A Chronology Of

Animation History
Computer Animation Technology

prepared by

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This is document CHRON4.DOC

360,000,000 BC - first known tetrapods (4 legged terrestrial vertebrates) appear.

1,500,000 BC - Kindling wood employed in building fire.

1,000,000 BC - Humans migrate out of Africa and use stone tools in Jordan.

350,000 BC - Alternate date for Homo erectus uses fire. [decide which you want Judson.]

250,000 BC - Brain capacity of neanderthal man exceeds 1000 cubic centimeters.

120,000 BC - Man builds shelters with roof supported by wooden beams.

50,000 BC - Body paint employed as decoration and camaflage.

43,000 BC - Homo sapiens matures; brain capacity exceeds 1500 cc's and spoken language is developed.

32,000 BC - Neanderthal hunters employ superimposed positions to depict the action of a running boar. First recorded drawings with temporal component. [but isn't the date too early?]

25,000 BC - Clothing begins to be tailored. Czechoslovaks make kiln fired clay figures of people and animals.

15,000 BC - Cave painters at Lascaux, France superimpose stars over the sketch of a bull creating the oldest record of a star constellation. Because most modern (Arabic) star names describe the part of the constellation where the star is located it is theorized that constellations were named before the individual stars.

8600 BC - Brick houses are built in Jerico, Palestine.

8450 BC - Accounting and counting systems: Persians use clay tokens as bills of lading for shipments.

8350 BC - Jerico is incorporated as first town. First bureaucracy.

8000 BC - Widespread domestication of plants and animats.

6500 BC - Seals are used to make impressions in clay.

6500 BC - Weaving of cloth perfected.

6000 BC - In Ishango, Zaire bone is cut with notches, mediatizing the grouping and counting activity.

3600 BC - Mesopotamians employ clay envelopes for tokens.

3500 BC - Mesopotamians invent pictographic writing in clay.

3500 BC - Widespread urbanization. During the next 500 years copper and bronze metal technologies are perfected.

3000 BC - Abacus sliding stone number register, counting, and procedures for adding and subtracting numbers.

3000 BC - Egyptians develop hieroglyphic writing.

2700 BC - Egyptians perfect basic surveying instruments and techniques, including the plumb bob, the square (and right angle), measuring rods (the ruler), the level, and the chalk line. Evidence of angular measurement slim.

2700 BC - Approximate date for origin of oldest known living thing on Earth, a bristle cone pine tree named Methuselah.

2500 BC - *I Ching* developed as model of universe.

2500 BC - Babylonians invent the zodiac, a band of 12 major constellations, or signs, through which the planets migrate and which encircles Earth. Each sign corresponds to 1/12th of the circle and is loosely correlated to the length of time for the moon to progress thru a full cycle of phases.

2150 BC - Babylonians use scale rules and scribes to draw plan of a ziggurat.

1800 BC - Phonetic alphabet evolved by Semitic tribes.

1700 BC - Babylonians employ precomputed multiplication tables.

1650 BC - Egyptian Ahmes compiles the *Rhind Papyrus*, a textbook of arithmatic problems and their solutions.

1500 BC - Babylonians create a baked clay tablet map of the town of Go-Sur that includes the river that flows through it and the nearby mountains.

1303 BC - Egyptian Pharaoh Ramses II initiates a systemic land survey of Egypt.

600 BC - Metal coins employed by Greeks.

585 BC - Thales of Miletus (Greece) developes five theorms about circles and triangles, explains how to find North using the pole star, and predicts an eclipse of the Sun, on May 28, that stops the battle between the Lydian Alyattes and the Median Cyaxares.

550 BC - Etruscans assign names to 8 principle winds, and these names become 8 equally spaced angles of the wind rose, a circular chart resemblina a compass.

550 BC - Pythagoreans discover that the length of a string dictates the pitch of a note, and thus observe that numerical ratios underlying musical intervals, and formalize the musical scale.

532 BC - Pythagoras formalizes geometry as a study of axioms, definitions and theorems. He identifies four of the five regular polyhedra. [subset of this in chap 6 chron]

500 BC - Greeks convert from writing right to left to writing left to right. The Romans will make similar conversion 200 years later.

470 BC - The Greek Hippasus discovers the dodecahedron, the fifth and last of the regular polyhedra to be identified. He is drowned by the other Pythagoreans after bragging about his discovery.

425 BC - Zeno of Elea proposes four paradoxes on motion.

425 BC - Theatrical proscenium introduced by Greeks to demarcate the stage space and frame it for viewing.

400 BC - Menaechmus explains conic sections to Alexander the Great.

400 BC - Murals in Pompei anticipate the formulation of perspective.

375 BC - Archytas of Tarentum, in Greece, constructs a one of the earliest known automata, a mechanical bird.

370 BC - Greek Eudoxus proposes a model of the heavens as a series of concentric spheres. The retrograde motion of the plants is described as a hippopade curve, which resembles a figure 8 and is produced by two homocentric spheres turning with equal but opposite velocities around axes which are slightly inclined to each other.

350 BC - Aristotle consolidates six arguments to prove that the Earth is a sphere. He asserts the obliquity of the Earth's axis and establishes the concept of the equator, the poles, and the tropics of Cancer and Capricorn.

300 BC - Euclid's *Elements* includes discussions of plane and solid geometry, including points, lines, planes, and the construction of right angles, half angles, circles and arcs.

270 - Aristarch of Samos proposes the idea that the Sun is the center of the solar system, but the idea doesn't catch on.

250 BC - Oldest known astrolab, an instrument for measuring angular distance, particularly the sun, moon, or a star above the horizon. After 900 astrolabs began to be augmented with a rotating(?) ring called a spider or rete and inscribed with the zodac so that the astrolab can be used to tell the time of day. See below.

240 - Chinese astronomers make first recorded passage of Halley's comet.

236 BC - Eratosthenes of Cyrene, the chief of the library at Alexandria, employs a trigometric method and measures the circumfrence of Earth with an accuracy of 15%. One hundred years

later the experiment is repeated by Posidonius, whose result is 25% too small. Regretably during the next 1600 years, nobody bothers to recheck his result until after Columbus, sailing west in 1492, mistakes America for Asis and names the natives Indians.

200 BC - Archimedes of Syracuse advances computational geometry and publishes formulas and algorithms incluing the area of a parabolic segment, volumes of curved shapes, the law of the lever, and the principle of boyancy. He calculates the number of grains of sand [on Earth? in the universe?] to be equal to 10E54.

200 BC - Erathosthenes of Cyrene uses the solstitial armilla, a type of armillary sphere to determine angular obliquity of the ecliptic. An armillary sphere is an astronomical measuring instrument that models the great circle movement of the heavens using concentric rings. Erathosthenes' instrument consisted of one fixed ring and a rotating inner ring. One is aligned to the plane of earth's rotation and the other to the plane at which the heavens rotated around the earth on an annual basis. See 140 AD below.

200 BC - Oldest known celestial globe shows stars and constellations. This is called the Farnese globe because...

150 BC - Nicomedes in Greece describes a procedure to draw a conchoid.

150 BC - The Greek Crates builds a globe of the Earth. The globe has not survived but it is the first globe of which there is a record.

126 BC - Hipparchus applies trigonometric procedures in astronomical calculations. Hipparchus also describes the precession of the vernal equinox.

100 BC - Musical notation is developed in China.

49 BC - Romans, in Egypt, perfect the water level and plane table. The plane table is a drawing board mounted on a tripod. When used with an alidade, a pair of sights connected to a straightegde, it is possible to aim at objects and then recorded (drawn) a line on the plane table which corresponds to a vector from the plane table to the objects being sighted. The astrolab predates the plane table in measuring angles, but the plane table may be the first instrument to

record them, making it a topographical instrument. This is a starting point to prepare accurate maps.

???? - Romans adopt the compass, divider, and measuring caliper from the Greeks.

100 - Greek astronomer Menelaus, living in Rome, writes the *Menelai Sphaericorum*, the oldest known book on spherical trigonometry.

105 - China Cai Lun invents paper; eventually it will replace silk and wood as a writing mterial.

129 - Claudius Ptolemy, working in Alexandria, prepares the first general atlas of the world. It contains a world map and 26 detailed maps. [date this before or after the fire?]

140 - Alexandrians build the Meteoroskopion, an armillary sphere with 9 rings, including the horizon, the meridian, the equator, the Tropic of Cancer and Capricorn, the Artic and Antartic Circles, and the ecliptic. It is probably scaled with degrees.

249 Chinese Pei Hsiu describes the use of rectilinear divisions to make cartographic maps which contain accurate indications of distance and orientation.

~250 - Conflaguation of library at Alexandria in Egypt at the hands of the Romans destroys the largest collection of classical literature extant on the planet. This is the first metaphorical head crash of the human race.

500 - Abacus improved by addition of sliding wires.

500 AD - Byzantines at Gaza, Syria construct a waterclock with a Hercules android that strikes hours with a club.

624 - Arabs conquer Egypt; beginning of Arab technical and scientif prowess.

680 - Positional notation system with zero perfected in India.

700 - Printing on paper is perfected in China

800 - Charlemagne's court, in what is now Germany, introduces lower case letters into the Roman alphabet.

825 - Arab Al-Khowarizmi writes *Al-jabr* (Al-gebra).

900 - The astrolab is augmented with a rotating ring inscibed with the zodiac and called a rete. The enhancement makes it possible to tell the time of day throughout the whole year. This is done by first sighting on the sun and measuring its asmuth angle, rotating the zodiac to allign with the angle, and determing what time an arrow points to. This modern astrolab is sort of like a circular slide rule, only it calculates time of day from sun angle and season (time of year), not arithmetic operations on numbers.

910 - Paper money is introduced in China.

1000 - Arab Alhazen (Ibn al-Haitham) [see chap 3].

1000 - Norsemen sail to the new world.

1040 - Chinese invent moveable type.

1100 - Ancient knowledge from Greece and Rome begins to trickle into Europe via Arabia, North Africa, and Spain.

1100 - Chinese discover the principle of the magnetic compass.

1200 - Use of Arabic numberals spreads into Europe. The effect to simplify (or make possible) mathematical manipulations which are impractical using Roman numerals.

1202 - Fibonacci introduces Hindo-Arabic numerals, including 0, into Europe. But the concept is slow to catch on. In his writing he also recognizes debt as a negative asset.

1204 - The sack of Constantinople by ?? destroys most early Byzantine and Greek literature.

1240 - Albertus Magnus constructs an iron man android.

1256 - Roger Bacon builds a talking head android.

1296 - An Italian company publishes *La Compassos da Navigare*, a detailed harbour finding manual for the entire Mediterranean Sea, with bearings express in "half points," that is, halves of tghe angles defined by the 32 point compass, a compass with 32 basic directions.

1300's - Mechanical clocks in public places become popular. Often they are equipped with human-looking automatons called jaquemarts, or jacks, which strike bells with hammers and replacing live watchmen and bell ringers.

1382 - Nicolas Oresme uses coordinates to express mathematical functions.

1405 - Ptolemy is rediscovered in Europe and his *Geographia* is translated into Latin. During the next 300 years most of its cartographic errors are corrected.

1407 - King of France incorporates a College of Arms; and blazon--formal written descriptions of heraldic shields is practiced by the college.

1436 - Leon Alberti codifies a theory of perspective in *Della pittura*, bringing to the visual arts a long sought mathematical foundation comparable to that of music.

1450 - Coiled spring steel becomes widely available as a source of portable kinetic energy. It is uses especially in clocks.

1455 - Johann Gutenberg prints the Mazarin bible and perfects the concept of a printing press with moveable type. The influence of printing and engraving is widespread, and includes the printing of music, maps, and drawings as well as the written word.

1456 - The German astronomer Johann Müller constructs a mechanical flying iron eagle and an insect fly.

1489 - Johann Widman standardizes the plus (+) and minus (-) signs.

1492 - Martin Behain of Nuremberg builds a 20" diameter globe of the world which is the oldest terrestrial glove in existance. It contains no Americas.

1515 - The Planisphere, a stereographic projection, is perfected which produces an accurate flat representation of the celestial hemisphere inside a circle.

1557 - Robert Recorde introduces the equals sign (=).

1560 - Leonardo da Vinci uses coordinates for analyzing quantitative data for experiments on gravity.

1569 - Flemish cartographer Gerardus Mercator publishes a world map using a projection where longitude is represented by equally spaced vertical lines and latitude is represented by horizontal lines.

1579 - Grancois Vieta in France advances algebria notation, advancing the concept of variable names for unknowns.

1593 - Vena calculates π to 17 decimal places.

1614 - John Napier, in Scotland, discovers logorithms, setting the stage for the slide rule (1620).

1620 - First publication of logarithmic tables.

1620 - Englishman William Oughtred perfects the slide rule, and device which multiplies numbers by analogically displacing (sliding) the physical scales. The trick is that the scales are logorithmic, and that the displacement actually adds the logorithms. This is high magic (good stuff).

1620 - The theodolite is introduced, it is a portable instrument for measuring both horizontal and vertical angles using a sight and protractor like scales. The theodolite marks a significant advance over the Roman plane table and alidade, and during the next 100 years a series of emerging technologies are incorporated into this topographic instrument, including the telescope, the vernier scale, stadia hairs, and the new, miniturized spirit levels.

1620 - Englishman Edmund Gunter develops a surveying chain and system of measures that remains in use for over 400 years. Each link of the chain is 7.92 inches long. There are 25 links in the

length of the surveyor's rod, 100 links in the chain. 10 square chains equal one acre and there are 80 chains in a mile.

1631 - Oughtred introudces the multiplication sign (x).

1631 - Thomas Harriot introduces symbols for greater than (>) and less than (<).

1631 - Frenchman Pierre Vernier invents a technique of juxtoposing two sliding scales and increasing measuring accuracy approximately 10 fold. The two vernier scales have one unit of difference for each major unit--for example the second vernier scale has 11 divisions to an inch whereas the main scale has ten; whereever the two scales come into phase is the extra digit of precision.

1636 - John Hume introduces the idea of superscripts for power notation (A^n), but it is not until Newton that exponents are understood to be positive, negative, integer or fractions (1676).

1637 - Rene Descartes in France invents Analytic Geometry, dividing the plane with two perpendicular and quantitative axes. The benefit is a way to display functions of two variables, especially the conics, and the beginning of using graphics as an analytical method. [subset of this in chron6]

1637 - English navigator Richard Norwood invents a system for measuring speed on ships which utilizes a sandglass and a knotted rope; this is the origin of the term "knots" for measuring speed.

1639 - Cross hatching patterns employed by Marcus Vulson de la Colombiere are standardized for specific colors in depicting heraldic shields.

1642 - Frenchman Blaise Pascal invents digital adding machine which uses gears. Cogs automate carries. Values are input with rotary motion using the hand and a stylis. The machine can add and subtract; multiplication is accomplished with repeated additions and ofsets.

1655 - John Wallis devises symbols for greater than or equal to ($\geq$), less than or equal to ($\leq$), and infinity (xx).

1659 - Johann Rahn creates the modern divide symbol (÷).

1666 - Isaac Newton discovers the binomial theorm.

1669 - Telescopic sights are incorporated into theodolites.

1673 - Newton and Gottfried Leibnitz formulate calculus.

1673 - Leibnitz enhances Pascaline by adding a shifting bar so as to faciliate multiplication and divisions. Further mechanization of this concept occured in 1820 with the addition of the crank, and in 1850 with the addition of the keyboard.

1770 Charles Messier compiles a *Catalogue* of 103 nonstellar, deep-sky objects.

1700 - Irregular curve templates manufactured in Paris aquire name French curves.

1706 - William Jones introduces the modern symbol for pi (π).

1738 - Frenchman Jacques de Vaucanson builds an android flute player capable of playing a dozen songs.

1750's - *Tableaux mecaniques* —painted landscapes with moving figures, windmills, and objects driven by hidden clockwork— become popular.

1752 - An extravagant mechanical theater is completed in the Gardens of Hellbrunn at Salzburg. It consists of 113 hydraulically operated figures and takes 4 years to build.

1753 - Oldest mechanism capable of writing and drawing, currently in Vienna.

1756 - J. I. Brietkopf invents a mosiac system for typsetting music. A font matrix consists of separate note heads and stems so that simultanious notes (chords) could be typset on a single staff.

1955 - Leonard Euler introduces a symbol for summation (Σ).

1770 - Self contained spirit level introduced. Modern triangulated surveying begins in France.

1771 - James Watt perfects stadia hairs, a method of determining distances to distant objects. Two parallel lines are located in the eyepiece of a telescope or sighting instrument. By sighting a calibrated rod located at an unknown distance and observing the number of calibrations located between the two parallel lines the distance to the rod can be determined using similar triangles.

1775 - Accurate circle dividing machine tools are developed.

1777 - Euler introduces the symbol *i* to stand for the square root of -1.

1783 - Frenchmen Pilatre de Rozier and Marquis d'Arlandes become the first men to ascend from the planet, in a hot-air balloon built by Montgolfier. By the following year the English Channel is crossed by balloon.

I786 - Swiss William Playfair publishes *The Commercial and Political Atlas*, which makes extensive use of time-series line and bar graphs to display economic data. This marks a beginning of the Business Graphics Age.

1804 - Frenchman Joseph Jacquard builds automated loom what uses punch cards for sequence memory. The card program determines how the weave is made and looks; very complicated weaves become possible.

1808 - Christian Kramp introduces the factorial symbol (!).

1812 - Tshaskovich combines visuals (fireworks) and music in his *1812 Overature.*

1814 - J. H. Hermann in Bavaria invents the planimeter, an analog computing instrument to measure (integrate) the area of an arbitrary irregular polygon. It works by tracing the outline and displays the result as a horizontal ofset.

1820 - Charles Thomas augments Leibniz's calculator with the addition of a crank, setting the stage for the modern calculator.

1822 - Jean Fourier advocates a formal technique to analyize functions, especially effective for functions that are periodic, such as electric currents, machine motion, or tides, moon phases, and seasons. This approach is called harmonic analysis, and works by progressive decomposition of a complicated waveform into sinewaves of constant frequencies; oftentimes only a few basic frequencies are needed to explain the "apparently complicated" system. Fourier's theorm asserts that if an infinite number of sinewave frequencies are allowed, that any waveform can be analyized (approximated) this way. Unfortunately any waveform that requires more than a few "coefients" as they are called lacks obvious major influences.

1822 - Charles Babbage theorizes the Difference Engine, and history differs if it ever worked. Pictures of it depict a machine with three decimal readouts (registers) each five digits long. Babbage later theorizes the Analytical Engine.

1822 - English scientist Michael Faraday demonstrates the principle of the electric motor, which converts electrical energy into rotary mechanical energy. The motor is the opposite of the dynamo, invented by Farady in 1831, which converts rotational mechanical energy into electricity.

1826 - Non-Euclidean geometry development begins. During the decades N. I. Labacheveski, Johann Bolyai and G. F. Riemann publish theories that concern issues such as projective geometry, which we use in computer graphics to simulate lens perspective.

1831 - Captain James Ross Clark becomes the first person to reach the North Magnetic Pole, situated on Boothia Felix, King William Land, Canada. In 1841 he estimates the location of the South Magnetic but it is not actually visited until 1919.

1840 - Projective geometry is perfected as a formal basis for perspective. It involves two major theorms concerning non-linear geometry and the notion of parallel lines meeting at infinity. Projective geometry links plane geometry and spherical geometry by providing a wide choice of mappings.

1840 - French photographer Hippolyte Bayard creates the earliest known example of a photographic fake by posing as a drowned corpse.

1841 - Semaphore signals is introduced on railroads as a signaling device.

1841 - K. Weierstrass introduces absolute value notation (|A|).

1843 - William Hamilton and Hermann Grassman introduce n-dimensional geometry.

1843 - Charles Wheatstone, in England, constructs the Wheatstone Bridge, an analogue computer for measuring electrical resistance.

1850 - Commercial manufacturing of irregular railroad curve templates, and of ship's curves which consist of conic sections spliced together.

1850 - Leibniz calculator augmented with a key pad. Rapid calculator progress follows: in 1857 a four function key driven calculator is introduced, in 1887 multiplication is simplified, and in 1888 Burroughs adds a printing capability.

1850 - J. J. Sylvester introduceds the term matrix.

1852 - French scientist J. Foucault invents the gyroscope, a essencially a spinning flywheel mounted on gimbles and used to measure angular displacement as well as promote stability.

1852 - In Boston William Channing and Moses Farmer install the first fire alarm system.

1854 - Englishman George Boole publishes *The Laws of Thought*, defining the logic of processes and formulating an algebra of logic, incorporating the concepts of TRUE and FALSE, and the logical operators AND, OR, and NOT.

1854 - Sweed Pehr Scheutz constructs a working difference engine. It contains 15 decimal registers.

1855 - Florence Nightingale invents the polar area diagram, a type of pie chart.

1857 - Sweed Oscar Rejlander combines 30 negatives into a single 31x16" print called *The Two Ways of Life* and which depicts an elaborate setting with many models.

1860 - Coleman Sellers in Philadelphia poses still pictures of actors in successive phases of action and mounts them on a paddle wheel viewer, similating live action. The device is called a kinematoscope.

1860 - English logician Augustus De Morgan formulates a theorm relating logical AND, OR, and NOT into single equations.

1865 - Rotary printing press perfected.

1865 - Harpers Weekly uses manipulated photographs of dead soldiers at Gettsyburg; this is an early example of photographic manipulation for new reporting.

1866 - Englishman Alexander Clarke calculates a reference spheroid of Earth. It is slightly squat and buldges at the equator; the polar diameter is about 27 miles less than the diameter of the equator.

1866 - W. F. Stanley writes a treatse on drawing instruments which remains the standard reference work until the drawing machine becomes obsolete circa 1960.

1866 - Transatlantic telegraph cable is completed from England to Newfoundland, in North America.

1867 - American Charles Pierce relates Boolean logic to electrical switching circuits.

I867 - C. L. Sholes, of Milwaukee, Wisconsin perfects the typewriter, a set of font matrix characters attached to hammers which strike an inked ribbon and impress their pattern onto paper.

1868 - Woodruff filing cabinet standardizes recordkeeping, storing paper records in 5 x 11 x 8" bins.

1875 - International Metric System is introduced.

~1879 - John Venn developes a diagramatic system using overlapping circles to depit relationships between sets

1879 - Cash register is introduced.

1881 - Charles Boys invents the **integraph**, an analog graphic instrument used to trace a graph and draw its corresponding integral curve.

1884 - Georges Seurat paints Sunday afternoon at the Grande Jatte, which illustrates the pointelist theory of discrete color dots blending into an overall image.

1885 - German born Ottmar Mergenthaler, working in the United States, invents the Linotype, a typecasting machine that is keystroked and which outputs cast lines of type, ready to lay into a frame and print with.

1892 - Emile Reyaud opens Theatre optique at the Mesee Grevin Way Museum in Paris. Reyaud projects animated moving drawings using his praxinoscope, which rear projects a series of individual hand painted frames on perforated roll paper onto a screen.

1887 - Felix Lucas builds an electric polynomial equasion problem solver. [huh? eb14]

1889 - Giuseppe Peano introduces a mathematical symbol for membership.

I891 - The step by step rotary switch is invented by American Almon Strowger and in 1896 an associates invents the telephone rotary dial. These technologies are applied to switching telephone calls but it is not until I9I9 that they are adopted by the Bell System.

1890 - American Herman Hollerith constructs a mechanical tabulating machine to count punch cards. The speed is at the rate of 50 to 75 cards per minute. In 1896 he forms the American Tabulating Company, which in 1926 becomes IBM.

1893 - Peano advances a symbol for logical not (~).

1894 - Operational date for origin of cinema medium.

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

1895 - Caricaturist Tom Merry in England is filmed making a lightning sketch of Kaiser Wilhelm. The film is not animated, but the technique is a precursor to animation. Another vaudville performer, George Méliès, is also filmed making lightning sketches, but the camera is cranked slowly so the action is accelerated when projected.

1895 - Edison studio uses a trick photography technique called the ARRET to behead a woman in *The Execution of Mary Queen of Scots.*

1896 - The Lumiere brothers dispatch cameramen on tours all over the world. In Russia they film the first newsreel--the Corination of 1896. During the next 18 months the Lumiere crews shoot over 2000 OBSERVATIONAL FILMS, and new techniques emerge rapidly. Venice and the banks of the Nile are shot from moving cameras placed in boats. And the Liverpool shipyards are shot using a panning camera.

1896 - Robert Paul, in England, invents the cranked PANNING HEAD for a motion picture camera.

1896 - George Méliès makes his first trick film, a cinematic variation of the *Vanishing Lady* magic act that uses an ARRET, or jump cut.

1896 - Hard coloring is used in early films. [Example? This is redundant with chapter 3, where we have a good example.]

1897 - Lightning cartoonist J. Stuart Blackton is filmed at the Edison studio performing his lightning sketch act. Three years later Blackton will combine animation into his filmed act.

1897 - Arthur Melbourne Cooper animates first advertisements for *Bird's Custard Power* in England. [How?]

1897 - George Méliès uses minatures—model ships—to restage a naval battle in *The Greco Turkish War.*

1897 - First use of permits and customs to control motion picture production and distribution is waged by the Americans against agents of the French Lumiere company.

1897 - In England Cecil Hepworth pubishes *The ABC of Cinematography.*

1898 - Méliès advances naval battle stagecraft further, blowing up the *Battleship Maine* in Havana Harbor, and then shooting divers through a fishtank as they recover bodies.

1898 - In America, J. Stuart Blackton and Albert Smith stage *The Battle of Santiago Bay*, another naval epic using models, and discover the ARRET, used in *Humpty Dumpty Circus*, thought by some to be the first stop motion film in America.

1898 - Albert Michelson and Samuel Stratton build a HARMONIC SYNTHESIZER that uses cranked eccentrics and levers to move a drawing pen; the resulting drawings are called HARMONIGRAMS. (You can buy one today in a toy store; with trade names like the *Mechanico*, the *Magic Designer*, and the *Spirogram*. The harmonic synthesizer is similar to the pendulum harmonigraph except it does not loose energy as the swinging pendulum does. It is a complementary output device to the HARMONIC ANALYIZER.

1899 - Arthur Cooper makes first STOP MOTION commercial, for Bryant and May Matchsticks called *Matches Appeal.*

1899 - Paul builds a movie studio equipped for special effects and with a moviable camera.

1900 - J. Stuart Blackton, at Edison Black Maria studio in New Jersey, combines stop frame animation of drawings and live action in *The Enchanted Drawing,* a chalk talk elaborated with some camera trickery.

1901 - Lumieres advocate the PHOTOROMA, a 360° surround film experience. During this period they also experiment with 70mm (1900), and 3D using glasses (19xx).

1902 - Méliès combines live action documenary photography with staged live action in *The Corination of King Edward,* which was rushed into the theaters.

1902 - George Méliès makes *Voyage to the Moon,* and uses elabolate theater stage flats carefully drawn and painted, moving and mechanical props, pyrotechnics, and actors. One of this trick devices is a sophsicated use of the DISSOLVE. In *The Man with the Double Head* Méliès plays two roles on the screen at the same time, probably a first; it is accomplished with a DOUBLE EXPOSURE. By the following year, in *Melomanic,* Méliès shoots MULTIPLE EXPOSURES of five and more passes. His trickfilm tools now include the arret, cuts, fades, dissolves, double and multiple exposures, and hand coloring, but it is uncertain that he ever uses stop motion.

1902 - American George ?? Sheffield proves that all arithmatic and logical functions reduce to NOTAND.

1903 - Edwin S.Porter directs *Life of a Fireman* and *The Great Train Robbery*, sometimes called the first PHOTOPLAY, because it fuses cinematography and storytelling. Both make extensive use of trick photography, including the STATIC MATTE, used in The Great Train Robbery to capture a moving exterior.

1903 - Zecca, directing for Pathé, makes use of REVERSE ACTION in *Le Plongeur fantastique.*

1903 - The Wright brothers demonstrate that a controllable airplane requires controls for three degrees of freedom: YAW, PITCH, and ROLL.

1904 - Offset lithography perfected. One derivative product is the office mimeograph machine.

1905 - Spaniard Segundo de Chomon in Paris makes a trick motion film, *El Hotel Electrico,* using STOP MOTION photography.

1905 - Méliès installs mercury lights into his movie studio.

1905 - Edison's studio employs animated title cards in *How Jones Lost His Roll.*

1906 - Porter, in adapting Windor McCay's comic strip *The Dream of a Rarebit Fiend,* begins experimentation with model animation and has animated shoe walking.

1906 - Electrical signal amplification, a kind of analog computing, becomes realistic with invention of tiode, by Lee deForrest.

1906 - Another ARRET beheading, this time by Méliès in Paris. France bans the execution shot in 1911, an early censorship.

1906 - Walter R. Booth, in England, incorporates stop-action filmmaking.

1907 - Blackboard chalk SCRATCHONS are single frame photographed onto a film in J. Stuart Blackton's *Humorous Phases of Funny Face*. This film is often sited as the first drawn 2D ANIMATION.

1907 - Blackton and Smith fuse single frame 3D MODEL ANIMATION and live action in order to depict a bottle pouring its own wine, a hand slicing bread and other antics in *The Haunted Hotel*. Vaudville audiences and the experts were dumbfounded. This is the first stop-motion film of 3D objects to achieve commercial success.

1907 - Porter's *The Eagles Nest* employs mechanical props.

1907 - D. W. Griffith creates the CLOSE UP. [better check this line out.]

1907 - Norman Dawn introduces the PAINTED GLASS MATTE PROCESS to Hollywood, in which part of the image to be photographed is painted on glass and hung in front of the scene.

1908 - G. W. Bitzer introduces CLAY ANIMATION in *The Sculptor's Nightmare.*

1908 - French newspaper cartoonist Emile Cohl develops an 2D ANIMATION technique of drawing with India ink on rice paper and then photographing the successive individual drawings. He makes numerious short films, including *Fantasmagorie* , his first film and the first CARTOON, and *Drame chez les Fantoches,* which uses 2D SHAPE METAMORPHOSIS.

1909 - Cohl innovates on the use of DOUBLE EXPOSURE printing to combine animation and live action in *Clair de Lune Espagnol (The Man in the Moon).* Cohl's method may have been to film the live first, process the film, count the frames, and plan the animation before

shooting it on a second negative, which was then double printed with the live action.

1909 - Cohl adopts the ELECTRICALLY DRIVEN CAMERA SHUTTER to get even exposures.

1909 - Multi-reel movies become popular.

1909 - American Rear Admiral Peary is the first person to visit to the North Pole of planet Earth.

1909 - Whitehead and Russell employ a special symbol for logical or (v).

1910 - Emile Cohl develops the silhouette method using 2D ARTICULATED CUTOUTS of a human figure made with linkages and joints for his film *Peintre neo-impressionniste.* C. Armstrong in England develops a similar method.

1910 - Edison makes first EDUCATIONAL FILM, *The Man Who Learned,* about the dangers of unpasteurized milk, and launches an industrial/training production unit that employed animation.

I9I0 - Bertrand Russell and A. N. Whitehead publish *Principia Mathematica.*

1911 - New York newspaper cartoonist Winsor McCay animates his *Little Nemo* character; this is the first animated cartoon to feature a newspaper comic strip character. The 3 minute hand drawn short is drawn on paper and photographed, and the prints are COLOR-TINTED by hand painting. The film makes the first use of CYCLES. It is a theatrical sensation.

1911 - Puppet animation advances when Polish-Russian Ladislas Starewicz uses stop motion to photograph 3D jointed mechanical insects in *Lucanus Cervus* The following year he makes *The Cameraman's Revenge,* which includes a special effect of film burning in the projector.

1911 - John Terry and Hugh Shields, in San Francisco, combine animation and live action by shooting onto a single emulsion using split reel technique.

1911 - Norwegian Captain Roald Amundesen is the first person to visit to the South Pole of planet Earth.

1912 - Paul Fenton, in Pennsylvania, develops cut-out animation.

1912 - Edward Rogers makes *War in Toyland*, an early puppet film that was also hand color-tinted.

1912 - All metal Bell and Howell 2709 camera with PIN REGISTRATION makes trick film more steady and is the centerpiece of line of professional equiptment that included a projector, printer, and film performator. Many are still in use today for animation cameras.

1912 - Frank Galbraith employs motion picture film to record the movements of factory workers and scientifically analyizes their actions. Galbraith`s scientific management seeks to analyize motion and increase worker efficency.

1912 - George Méliès makes his last of 500 films. In *The Conquest of the Poles* he makes use of AUTOMATON.

1913 - The term ANIMATED CARTOONS is used for the first time in a film advertisement for *The Newlyweds* by Emil Cohn.

1913 - Most primitive camera effects have been discovered by now and are firmly understood, including the ARRET, STOP MOTION (aka single frame), MULTIPLE EXPOSURES (superimposition and split reel with mattes), REVERSE ACTION, SLOW and FAST MOTION, UPSIDE DOWN, DRAWING and PUPPET ANIMATION, as well as fADES and DISSOLVES, IRIS WIPES, change of FOCUS and APERATURE, and CAMERA MOVES.

1913 - Raoul Barré, a Canadian, opens the first animation studio (in the Bronx).

1913 - John Bray, another newspaper cartoonist, opens a production studio in New York where he will introduce a series of technological enhancements. These begin with the introduction of registration marks into the all four corners of the drawings for *The Artist's Dream.* He develops a character for the *Colonel Heeza Liar* theatrical short series.

1913 - Cartoonist Bud Fisher's *Mutt and Jeff* is adapted to the screen.

1914 - Windsor McCay animates *Gertie The Trained Dinosaur,* and tours vaudville. McCay is now managing animation using what is called the SPLIT SYSTEM: action is divided into a first, last, and middle pose, and then recusively subdivided into individual poses. In modern parlance this is the concept of EXTREMES and INBETWEENS.

1914 - Barré invents the PEG SYSTEM, consisting of holes in paper and registration pegs to keep the drawings steady. Next, he prints static scenes on paper and animates by cutting away the paper where the scene is changing and drawing the moving parts of the image on separate (in-register) sheet of paper laid underneath it; this is called the SLASH SYSTEM.

1914 - John Bray patents a multi-level graphic animation system which includes holdbacks, transparent cels, and cutouts overlaid atop background. A second Bray patent introduces a range of grey tone into the drawing.

1914 - Wallace Carlson in Chicago combines animation with live action.

1915 - American Earl Hurd (working at Bray's studio) defines the CEL PROCESS. Animation becomes an industry and incorporates patents, job specialization, and the assembly line.

1915- Bill Nolan introduces the TRAVELING BACKGROUND into cartoon film, this is a moving panoramic background.

1915 - D. W. Griffith's *Birth of a Nation* proves that the concept of long format film entertainment is viable. Griffith uses the French made wooden Pathe camera, with 400 foot magazines, a footage counter, and a film speed indicator.

1915 - New York cartoonist Max Fleischer patents the ROTOSCOPE process. His most successful character is Ko-Ko The Clown, staring in *Out of the Inkwell,* made in the late teens. His other major characters, Betty Boop and Popeye, arrive in the 30's.

1915 - GYROSCOPES begin to be used as stabilizers on ships.

1916 - The ARTIFICAL HORIZON for airplanes incorporates a gyroscope principle and provides indices of ROLL and PITCH angles. It facilities flying at night and inside clouds.

1916 - Segundo de Chomon and Giovanni Pastrone in Italy make a long puppet and live action film entitled *Le Guerra E Il Sogno Di Momi.*

1916 - Bray patents the transparent background overlaying a moving cell. This creates the illusion of characters passing behind objects.

1916 - Helene Smith Dayton in New York invents CLAY ANIMATION: figures are molded in clay and moved and resculpted between exposures.

1917 - Quirino Cristiani, in Argentina, makes the first FEATURE LENGTH ANIMATED FILM, called *El Apostol.*

1917 - Moving doll puppets are used by Howard S. Moss to make film. Technique uses thread and wire, and a method to change facial expression.

1917 - First film of American stop motion animation pioneer Willis O'Brien, *The Dinosaur and the Missing Link*, and the beginning of a career animating animal puppets that will culminate in *King Kong.*

1918 - Paul Terry, San Francisco cartoonist opens studio, Mutt and Jeff are the primary characters.

1918 - TRAVELING MATTES patented by American Frank Williams.

1918 - McCay's *Sinking of the Lusitania* is first animated documentary.

1919 - Pat Sullivan and Otto Messmer animate *Feline Follies,* the first cartoon to star Felix the Cat, and the beginning of the first successful series. The personable cat was the first cartoon character to be licensed and during the 1920s his popularity rivaled Charlie Chapman. Felix was also the first cartoon star to appear on TV (1928).

1919 - Willis O'Brian animates volumetric dinosaurs in *The Ghost of Slumber Mountain.* In 1925 he animates 49 prehistoric creatures in *The Lost World,* where actors were trick photographed into some of the shots; this is the precussor to *King Kong.*

1919 - Sir Ernest Shackelton reaches the South Magnetic Pole of Earth.

1920 - American George Stallings perfects the rotating circular glass disc drawing table, so an animator can rotate drawings while working on them.

1920 - Photogrammic mapping from aerial photographs is perfected.

1920 - Card punching technology advances to include letters as well as numerals and capacity is expanded to 80 characters per card.

1920 - Marcel Duchamp and Man Ray construct *Rotary Glass Plate (Precision Optics),* a motorized construction of five painted plexiglas pannels rotating to create a spiral illusion.

1920 - Mitchell Standard 35mm camera is introduced. It features an all metal motor powered body with a lens turret, rackover focusing, and controls for fades, dissolves, and mattes.

1920 - Edwin Lutz authors the first book devoted entirely to animation entitled *Animated Cartoons; How They are Made, their Origin and Development*, published in New York by Scribner. Lutz's book is checked out of the Kansas City public library by a young Walt Disney.

1920 - John Bray makes *The Debut of Thomas Cat,* the first color cartoon, released in Brewster Color, a two emulsion color process.

1921 - Walter Ruttman screens *Lightplay Opus I* in Germany, thought to be first abstract movie. It is designed to be projected in accompaniat to a musical score written by Max Butting.

1921 - Lotte Reiniger in Germany makes *The Flying Coffer,* her first cutout silhouette animation film.

1922 - Western Electric makes animated sound film tests. In 1924, Lee De Forrest makes animated talking cartoon at the Max Fleischer studio.

1922 - Robert Flaherty's *Nanook of the North* begins the era of the film documentary.

1923 - *Hunchback of Notre Dame* employs miniature sets.

1923 - Eugene Schufftan patents a mirror process to combine paintings, models, or photographs with live action.

1924 - German Hans Richter and Swedish Viking Eggeling collaborate in making abstract animation called *Diagonal Symphony.*

1924 - Bell Laboratories is founded to consolidate the various research activities within AT&T.

1925 - Dodge Dunning invents in-camera travelling matte process using completary colors that works for black and white but not color.

1926 - Disney and others incorporate the key frame technique (defining the action line as extreme positions plus in-betweens, exposure sheets, the Moviola, and the ink and paint assembly line into animation process.

1926 - Lotte Reiniger completes the all-animated feature *Adventures of Prince Achmed* using jointed 2D silhouette marionettes. Two years later she makes *The Adventures of Dr. Doolittle.*

1926 - Fleischer makes the bouncing ball process to add music to the silent film.

1926 - Russian Sergei Eisenstein introduces a theory of montage into the vocabulary of film; *Potemkin* released.

1927 - The film *Metropolis* simulates a television by using a rear projection screen.

1927 - Alan Crosland directs *The Jazz Singer,* the first theatrical release with synchronized speech.

1928 - Felix the Cat is the first cartoon star to appear on television, on NBC in New York.

1928 - Paul Terry makes *Dinner Time,* the first cartoon with sound, voices, and music.

1928 - American Walt Disney makes the first animated synchronized sound cartoon, *Steamboat Willie,* premered at the Colony Theater in New York, which launches the character of Mickey Mouse. Disney will now assume leadership for cel-style animation innovation. Pluto, Donald Duck are born within a decade. Musical tempo now paramount.

1928 - Dodge Dunning syncronizes rear projection and live action photography. This is how most scenes in an automobile are filmed.

1929 - Americans Hugh Harman and Rudolf Ising make first lip synchronized dialogue cartoon, *Bosko The Talking Kid.* It is with this film they approach Leon Schlessinger at Warners (below).

1930 - German Oskar Fischinger choreographes abstract animation to classical music.

1930 - 24 fps is standarized as sound film speed.

1930 - Birth of Betty Boop, from the Fleicher studio.

1930 - Walter Lantz (later the creator of Woody Woodpecker) utilizes photomechanical coloring in the opening of *King of Jazz.*

1930 - Widespread use of IBM cards for bookkeeping.

1930 - The ninth planet, Pluto, is discovered using photo comparitive techniques.

1931 - New Zealander Len Lye draws directly onto film. *Color Box,* in 1935 is made in England.

1931 - Oscar Fischinger's *Brahms' Hungarian Dances* utilize moving abstract patterns in sync with the music, fully realized sound-music synthesis.

1931 - Harold Edgerton perfects electronic flash photography. The strobe's very short bright bursts of light frees high speed photography from the mechanics of the shutter and shuttle. Edgerton becomes famous for splashing water drops, a bullet penetrating a playing card, and a football at the instant it is being kicked.

1931 - Kurt Godel reveals that all logical systems contain a paradox.

1931 - Frenchman Etienne Bazeries perfects a hand held mechanical device to encyper messages. It consists of an alphabet positioned around a ring which pivots against a second ring.

1932 - Colored backgrounds are introduced into traveling matte process.

1932 - Disney makes *Flowers and Trees,* the first (Techni)color cartoon. This is the first animation to win an Oscar.

1932 - Willis O'Brian directs *King Kong* and combines live action, rear projection, the Dunning process, full scale articulated models, stop motion photography of minitures, and sound into a new genre of cinema.

1932 - Mary Ellen Bute collarborates with Leon Theremin and uses mathematical formulas displayed on a CRT and synchronized to music in visual-aural experiments.

1932 - Vanneuar Bush at MIT builds an analogue differential analyzer to do calculus using rotating shafts. In the machine the shaft rotary position represents value. Bush uses gears to multiply and divide, and differential gears to add and subtract. Integration is accomplished by rotating a sharp wheel at a variable radius on a circular rotating drum.

1933 - Pioneered by Linwood Dunn and others, optical printing emerges as a viable post production technology. It is dependent upon a new generation of dublication stocks and the optical printer itself, and brings a new precisions to scene transition. Dunn makes unprecidented use of optical printing, especially the wipe as a transistion device, in RKO's *Flying Down to Rio.*

1933 - Disney's *Three Little Pigs* is the first completely story-boarded cartoon.

1933 - Dutchman George Pal's *Puppet Tunes* evolve a technique of animating on paper, then (using a lucy) projecting the drawing onto the puppet set, bending the puppet accordingly, and then shooting the frame.

1933 - Alfred Tarski employs a symbol for logical and (^).

1933 - R. R. Mallock designs an analog electrical computer for solving linear equasions.

1934 - Salvidor Dali paints *Petites Vues:* 10 painted parallel and separated glass layers in a box. It is an anticipation of the multiplane camera.

1934 - Russian animator Aleksander Ptushko combines puppets, live action and sound in a feature, *The New Gulliver* and Starevitch (in France) makes *The Mascot.* Hungarian George Pal uses puppets in advertising film.

1934 - Warner Brothers cartoon unit created, with Leon Schlesinger as producer and Hugh Harman and Rudolph Ising as cartoonists. By the l940s, when Bugs Bunny meets Elmer Fudd, the Looney Tunes and Merrie Melodies directors included Tex Avery, Bob Clampett, Chuck Jones, and the stars include Porky Pig, Daffy Duck, Tweety and Sylvester, The Road Runner and Wile E. Coyote, and others you might recognize.

1934 - Alexander Alexeieff and Claire Parker animate *A Night on Bald Mountain* using a pixelated pinscreen. The rows of pins are mounted in a two dimensional screen; the pins are pushed and pulled to raise and lower them. When lit from the side the pins cast shadows; the length of the shadow (eg the amount of black at that pixel) is a function of the height of the pin.

1934? - Hayes Code regulations force the Fleischer brothers to remove cartoon heroine Betty Boop's garder and to lengthen her dress.

1935 - *Becky Sharp* is the first live action Technicolor film.

1936 - Englishman Alan Turing's paper "On Computable Numbers" defines the domain of computing. Turing's machine conceptualizes serial input messages that are interpreted by hardware processing logic which manipulates the input stream backward or forward and overwrites symbols onto it.

1936 - Konrad Zuse in Germany builds electromechanical calculator using relays and binary numbers.

1936 - John Wilbur builds a mechanical computer for solving linear equasions.

1936 - Soviet Union establishes the Soyuzmult film studio to produce animation.

1937 - August Arnold and Erich Koestner perfect a reflex viewing system for motion picture cameras which is manufactured by Arriflex in Germany. Its main advantage is that the camera operator can look directly and continuously at the subject being filmed.

1937 - Disney uses multiplane photographic camera in *The Old Mill.*

1937 - Walt Disney releases *Snow White and the Seven Dwarfs,* their first feature film, which included lip synchronized characters, sound and color.

1937 - MGM forms animation unit that employs William Hanna and Joe Barbera, the future Hanna-Barbera Productions. Tom and Jerry and the Roadrunner become major characeters.

1937 - Mechanical and electrical isograph analog computers are independently perfected to solve polynomial equasions with real coefficients. Thornton Fry and R. L. Dietzold build the mechanical isograph, which traces one or more sine and cosine waves and draws the result. The electric machine is constructed by H. C. Hart and Irven Travis. [check facts: is an isograph a polynomial solver?]

1937 - George Stibitz at Bell Labs builds an electric relay circuit that perferms boolean logic functions: binary input signals are converted to binary output signals. Using his "boolean gates" Stibitz construct a machine which adds two binary numbers.

1938 - Starevitch uses facial masks for different expressions.

1938 - Claude Shannon, in Boston, relates binary numbers, boolean algebra dnd electric circuitry.

l938 - Bell System introduces the mechanical crossbar switch into the phone system. It is used to switch calls at telephone exchanges.

1938 - George Philbrick, at the Foxboro Company, completes the Polyphemus, the first all electronic analog computer, and displays the results on an oscilloscope.

1938 - Chester Carlson invents xerography.

1939 - John Atanasoff and Clifford Berry build a prototype of a binary calculating machine. The machine as ?? registers, or memories, each 25 bits long, and one logic circuit, which can ??. The machine is similar to Stibitz's, but uses tubes (not relays), for the logic circuit. The memories are built from capacitors.

1939 - H. C. Montgomery build a photo-electric harmonic analyizer.

1939 - *Gone with the Wind* and *The Wizard of Oz* both verify the success of the Hollywood color feature.

1939 - Bell and Howell 71-Q Eyemo spring powered hand held 35mm newsreel camera becomes the most widely distributed professional motion picture camera of its era.

1940 - John Grierson founds The National Film Board of Canada. Norman Mclaren is one of its first stars of the abstract method.

1940 - Douglas Rockwell pioneers wax block method.

1940 - John and James Whitney employ a pendulum harmonium to make *Twenty-Four Variations on an Original Theme,* one of the first American abstract animation films.

1940 - Disney Studio's concert feature*Fantasia* pioneers stereo sound.

1940 - George Stibitz at Bell constructs The Complex Number Calculator. Binary circuits perform +, -, x, and / on binary numbers. Control is by teletype, either local, or via phone lines, enabling him to demonstrate remote computing. Logic circuits are constructed of relays, and memory consists of ?? words, each ?? bits long, and built out of ??.

1942 - Atanasoff and Berry built a special purpose CPU designed to solve simultaneous linear equations. The ALU is built from tubes. Two 30 word memories, each 50 bits long, are constructed from dynamically refreshed capicitors. The machine contains 30 ALU's, each of which perform one operation on a pair of memories for machine cycle. The CPU clock is in the form of the motor which is rotates the memory, at 60 rpm, giving the machine a cycle time of I second, and a power of about .000,030 mips (since there were 30 parallel processors). Transient result, as well as input and final results were via punch cards.

1942 - IBM commences the Automatic Sequence Controlled Calculator, or *Mark I,* designed by Howard Aiken at Harvard. It employed electromagnetic relay logic circuity and could =,+, -, x, and ??. Memory consisted of ?? words, each 23 decimal digits long, and implemented as relays ?? also. Instructions for the machine were programmed by punch tape, data was input via IBM cards using coded decimal format.

1943 - Turing builds *Colossus*, a decyphering machine that uses vacuum tubes (to simulate logic ?? to store data ??). The machine instructions include ??, as well as a test and branch operation. The data storage is ?? words, each ?? bits long, each containing a ??. Cyphered messages where input via paper tape, and the machine performed possible decodings, outputting them ??.

1944 - Whitney brothers employ pantographs to control paper cutouts for animation.

1945 - An Italian immigrant to the US, Armando Dal Molin, modifies a Sholes typewriter to print music, replacing the letters with notes.

1945 - John Mauchly and J. Presper Eckert in Philadelphia, build ENIAC. Its logical gates are constructed of tubes (18,000 of them), and 1000 bits of random access vacuum tube memory, each ?? decimal digits long. It occupies 3000 cubic feet of space, weights 30 tons, and consumes 174 kw of power. Data numbers are entered via IBM punch cards, programming is accomplished by patch cording the logic gates together. The machine implements a subroutine concept, lays the basis for internal storage and has a clock rate of 100,000 hertz. It performs 333 multiples per second, giving it a MFLOP rating of approximately .00033.

1945 - John von Newman publishes a "First Draft of a Report on the EDVAC" which describes the logical organization of the modern computer. He identifies its fundamental components, and makes key recomendations in a number of technology variables: digital not analog, tube not relay, binary not decimal, serial not parallel, and able to store data as well as programs in a common memory. Von Newman's specs fillfull a full Turing machine. This mode of computer design dominates the rest of the century.

1945 - Vanneuar Bush writes "The Way We Think" where he envisions an interactive computer system for accessing books and records. This is widely cited as the origin of digital information processing.

1946 - The rotary drum desk calculator, the so called "Monroe Machine," begins a period of widespread use. It incorporates a keyboard, retains the addend, and can add, subtract, multiply and divide.

1946 - IBM 603 computer uses decimal representations, tube electronics.

1946 - Point to point microwave relay networks begin to be installed to handle long distance telephone traffic.

1947 - Transistor is invented at Bell Labs.

1947 - Pegbar is standardized in motion picture industry.

1947 - *Blinkity Blink* by Canadian Norman McLaren uses patterns painted directly onto film.

1947 - Grace Hopper documents the first computer bug, a dead moth found inside the *Mark II*, by pasting it in her notebook along with a description of the incident.

1948 - Claude Shannon, now at Bell, defines information theory and proposes a method of define and measure information (quanity of bits). In his spare time he constructs a chess playing machine.

1948?- Ralph Shaw and Engineering Research Associates prototypes The Rapid Selector, a mechanized filing and searching system.

1948 - IBM begins work on its first electronic computer, the Model 604 Selective Sequence Electronic Calculator.

1949 - Olin Dupy at MGM builds motion control aparatus for camera control that will record pan and tilt movements onto a phonograph record and play them back. Early analog motion control unit.

1949 - First experiments with front projection.

1949 - Jiri Trnka, in Chechoslowakia, opens puppet studio. Others there include Hermina Tyrlova and Karel Zeman.

1949 - Maurice Wilkes at Cambridge, England builds the first stored program computer, the EDSAC (Electronic Delay Storage Automatic Calculator). It is a fully binary vacuum tube machine (??) with ?? words of ?? bit memory.

1949 - MIT's Jay Forrester invents magnetic core memory.

1949 - Phototypesetting introduced.

1950(?) - United Productions of America (UPA) introduces *Gerald McBoing Boing*, and a new flat graphic style, often called LIMITED ACTION where design and caricature assume precedence over action.

1951 - "Totalized Animation" is introduced in which 3D models are in motion during shot.

1951 - Mauchly and Eckert, at Remington Rand, complete *UNIVAC*, the UNIVersal Automatic Computer, an electronic stored program machine for commercial use. Seriel number one is sold the US Bureau of the Census. Its cycle time is 2000 operations per second, or .002 MIPS. One of its input/output devices is magnetic tape.

1951 - Ken Olsen and Jay Forrester at MIT build the *Whirlwind I* computer. It has 1024 words of 16 bit memory and performs 20,000 operations per second. It is equipted with a CRT display and movie camera and some of the very first computer animation is produced on this machine.

1951 - Otto Schade of RCA defines the optical transfer function, which applies information theory to the behavior of lenses.

1952 - Electronic Associates Inc in New Jersey manufacture the *16-231R*, an analog computer. Over 500 are sold, making it the largest selling analog computer. Among other things it is used to design the nuclear reactor for the Nautilus and perform flight simulation for the X15.

1952 - Ben Laposky begins making *Oscillons*, analog computer art pictures displayed on a CRT oscilloscope and controlled with dials, and shot onto black and white film or onto color film using filters.

1952 - IBM introduces its first stored program computer, the *701*, a tube machine which uses binary representations.

1952 - Werner von Braun proposes an earth orbiting space station.

1953 - Crick and Watson discover the genetic code. Nature uses a programming language.

1953 - IBM(?) perfects the light pen.

1953 - IBM introduces their first magnetic tape digital recorder, the Model 726. It has a density of 100 bytes per inch and a transfer rate of 75 inches, or approximately 60,000 bits, per second. Magnetic drum storage is also perfected this year.

1953 - McLaren explores stop motion pixillation technique in film *Neighbors.*

1953 - *The Tonight Show* goes on the air at WNBC-TV, New York. Its original host is Steve Allen, and subsequent hosts have included Jack Paar (19??), and Johnny Carson (1962). It is the longest running TV program in American history.

1954 - IBM introduces 650 computer. It is a small business computer that reents for $4000 a month and during the next 15 years 1500 units are sold.

1954 - Reynold Johnson invents the rotating magnetic disk at IBM's San Jose research lab.

1954 - First compiler: John Bakus at IBM develops Fortran (FORmula TRANslator), a programming language which supports matrix as well as scalar variables, simple arithmatic, assignments, conditionals, branch and subroutine calls, and machine independent I/O. Subordinate to a standarized machine independent syntax are concepts such as language portability, subroutine libraries, device portability, and other concepts essencial to computer animation.

1954 - John Halas and Joy Batchelor animate a feature length serious work, *Animal Farm.*

1954 - Bute and Dr. Ralph Potter collabolate to produce *Abstronic* which uses an oscilloscope.

1955 - Motorized animation stand introduced by John Oxberry includes double columns, automatic follow focus and rotating table.

1956 - IBM announces the 704, a commercial vacuum tube computer. By the end of 1957 it has 87 machines of the 700 series in operation worldwide. Customers could purchase a point addressable CRT as an output option, a first, and although the 704 included an "advance film frame" instruction, the tube had no vector or character mode and was intended for microfilm recording, not interactive display.

1956 - George Price, writing in Fortune, theorizes The Design Machine, an interactive CG CAD/CAM system complete with an "IBM 704 computer, a Hughes Aircraft Memotron memory-type picture

tube, and an automated machine tool." The system employs virtual models, a function key pad menue, and a rotator ball, dial and joystick to effect primitive transformations.

1957 - IBM begins shipping the first disc drive, the IBM 350.

1957 - The Air Forces operationalizes SAGE (Semi Automatic Ground Environment), a computer mediated system for graphic display of aircraft and air defense. It employs an IBM AN/FSQ-7 computer that weighs 175 tons and which combines tube and rotating drum memory, and displays radar blips on a CRT with a light pen.

1957 - Russel Kirsch and others at National Bureau of Standards employ a rotating scanning drum with a photoelectric cell to digitize picture and store it in a computer.

1957 - Ken Olsen leaves MIT and founds Digital Equiptment Corporation.

1957 - Two Chinese-American physicists, Tsung Dao Lee and Chen Ning Yang receive the Nobel prize for a theory that elementary particles are asymmetric; their antiparticles are identical but have opposite charge. This is an analogy at the atomic level to stereoisomers at the chemical level.

1958 - John and James Whitney employ mechanical CAM equipment to manipulates templates. Products of this analog motion control computer include *Lapis* (1962-1966).

1958 - Seymour Cray builds the first fully transistorized supercomputer, the Control Data Corp 1604.

l958 - The LISP language is invented by John McCarthy, who coined the term "artifical intelligence." Lisp provides a programming approach whereby formal rules may be structured for tasks like theorm proving and artifical intelligence.

1958 - The first computerized system for banking, Electronic Recording Method of Accounting (ERMA) is introduced. It includes a method of writing numbers on checks with machine readable characters printed using magnetic ink.

1958 - William Higinbotham, at the Brookhaven National Laboratory, constructs a "video game" precursor to Pong, an electronic two person tennis game constructed with tubes, relays, a time sharing circuit, and an oscilloscope display. A static court and net was alternatively displayed with the moving ball. Players hit the ball by pushing a button and adjusted the angle of hit by turning a knob.

1959 - Jack Kilby and Robert Noyce at Fairchild Semiconductor perfect a manufacturing processes for integrated circuits.

1959 - Digital Equipment Corp. introduces first successful minicomputer, the PDP-8. It contains only 8 different instruction codes and costs $50,000. During the next 25 years over 100,000 are manufactured and sold.

1959 - Grace Hooper mothers the language Cobol, demonstrates a the concept of a portable language that can run on different computers.

1959 - Exhibition of CRT graphics [ck C. Goodman]

1959 - Calcomp of California introduces a commercial drum plotter along with a software subroutine driver package.

1959 - Croma-Key process introduced which permits real time video color matting.

1959 - Xerox introcduces the office copier.

1959 - Leon Harmon at Bell Labs perfects a device able to recognize handwritten numbers.

1959 - Waldo Tobler, at the University of Washington defines the concept of computerized cartography in the paper "Automation and Cartography" in *Geographical Review*.

1960's ? - Blue screen process

1960 - William Fetter at Boeing begins making plotting templates of airplane parts and quickly advances to creating 3D vector graphics. During the next few years he will create some of the first three dimensional computer animation.

1960 - Laser rangefinding techniques perfected.

1961 - Disney Studio replaces hand inking of cells with xeroxography process, used in film *101 Dalmatians.*

1962 - William Fetter at Boeing makes the *Second Man,* an animated digital database of a human figure used for reach studies. It is unknown if films or loops were made of this action or if it was only output onto paper.

1962 - Ed Fredkin founds Information International Inc. (III) and begins to manufacture film scanner/recorders.

1962 - Fairchild and Texas Instruments begin to manufacture chips.

1962 - American Steve Russell writes the program *SpaceWar!* on a PDP1 computer, perhaps the first computer video game.

1962 - American Edward Thorpe uses a computer to develop a strategy for winning a blackjack. The theory recognizes that odds change based on what cards have already been played out of the deck.

1962 - American Major Robert White files the X-15 to the edge of space, setting an altitude record of ???.

1962 - Canadian Ken Iverson generalizes a notation for matrix product and one which can also execute on a computer.

1963 - IBM 7040 computer incorporate transistors.

1963 - Control Data Corporation (CDC) introduces the fastest computer ever made—the CDC 6600—and ushers in the era of the supercomputer. Seymore Cray is one of the principle designers.

1963 - Steven Coons at MIT integrates a formulation of perspective depth into a system of general linear equasions and formulate the popular homogeneous coordinates system used to represent transformations in computer graphics.

1963 - Ivan Sutherland's Sketchpad at MIT demonstrates practicality of interactive computer graphics including menue and

picture driven activities, freehand and constrained drawing, and object editing and positioning.

1963 - The Stromberg Carlson Corporation introduces the Stromberg Datagraphic 4020, or SD-4020, an offline film recorder that may be used to record motion pictures. The basic model comes with a capstan driven camera but Sherril Martin, then living in Concord, Massachusetts, adapts a pin registered 35mm camera to the SD-4020 at Lincoln Labs at MIT, so that precision filming can be done.

1963 - Ed Zajac at Bell makes *Two-Gyro Gravity Gradient Attitude Control System* using a Fortran subroutine package (similar to the Calcomp interface) plus a Fortran program. This is very likely the first computer animated film as well as a genuine scientific visualization.

1963 - Larry Roberts at MIT writes a computer program to remove the hidden lines in a three dimensional perspective drawing.

1963 - William Fetter coins the term "computer graphics."

1963 - Touch Tone dialing introduced into the Bell System.

1964 - Rand Corp. makes first data tablet.

1964 - IBM System 360 computer fuses decimal and binary representations into a single architecture and implements it as a series of machines with a gradient of price-performance. The 360 machine language is incompatable with the previous machines but emulates them. The initial 360s employes low density integrated circuits; in the 1970s the architecture is expanded to produce the 370 line, which includes additional paging instruction and is constructed with higher density integrated circuits; in the eighties, it is expanded further to produce the 30xx machines (eg, the 3080, 3090) with extended addressing and vector instructions. During this entire period the instruction set of the basic machine remains consistant and upwardly compatable with the newer designs.

1964 - BASIC and APL interpreters are developed; instead of being compiled and executed, code is executed interactive a line at a time. BASIC, created by Tom Kurtz and John Kemeny of Dartmouth, resembles FORTRAN. APL, developed by Ken Iverson at Harvard in

1957, operates on entire matrices and incorporates a program stack so it can execute recursively.

1964 - Ken Knowlton's BEFLIX language at Bell Labs defines primitives to manipulate a 252 x 184 pixel grid. Knowlton's primitives include pixel read-write, area copy, area scale, and area permutation by rule. Stan VanDerBeek, Lillian Schwartz, Leon Harmon, Lou Katz and Joe Scala are early colabolators.

1965 - Robert Langridge makes first films of real time interactive computer graphic 3D molecular models and protein structures at Project Mac at MIT. The project involves minimizations of molecule energies.

1965 - Bell System introduces electronic 1st telephone switching system that uses stored program memory.

1965? - IBM introduces the 2250 interactive CRT display for the System 360, including a lightpen and handlers. Early applications include CAD/CAM, command and control, and weaving.

1965 - Tony Conrad makes *The Flicker*, a film made entirely of black or white frames in varying rhythms. Conrad may not have know he was making an entirely binary movie.

1965 - Korean Nam June Paik purchases Sony Portapack and declares video art.

1965 - Digiset introduces electronic character generation to video.

1965 - Computer Graphics Exhibition at the Howard Wise Gallery in New York features the work of two Bell Labs researchers—Michael Noll and Bela Julesz .

1966 - Dal Molin in the United States develops a computerized system to write music. Input is via a typewriter keyuboard and output is via a phototypsetting machine.

1966 - Control Data Corp and Bell Labs make point digitized image. The Bell work is spearheaded by M. Sch..., Leon Harmon, and Ken Knowlton.

1966 - MAGI Synthavision is first animation system to include command language and three dimensional solid geometry.

1966 - First rendevous and docking of vehicles in Earth orbit, between American Neil Armstrong and David Scott in Gemini VIII and an unmanned target vehicle launched ahead of them in orbit.

1967 - General Electric in Syracuse builds a real time interactive computer graphics system with shaded color solid objects with hidden surfaces removed.

1967 - Tokyo Computer Group demonstrate computerized in-between, "Running Cola is Africa".

1967 - Michael Noll at Bell Labs makes first computer animated stereo movie.

1967 - Michael Noll at Bell Labs makes first films of computer animated stereo 4-D objects: *Four Dimensional Hyperobjects* and *4-D Hypermovie.*

1967 - John Whitney at IBM computes *Permutations.*

1967 - Brooklyn Polytechnic establishes computer animation department.

I967 - Users of Automatic Information Display Equiptment (UAIDE) create a Computer Animation Committee. The purposes of the committee include the exchange of technical information, recommendation of hardware and software, and the establishment of standards. Computer animation is defined as including, but not necessarily limited to "the production of motion pictures on film, video or other visual communications media using active or passive graphic output devices driven by computer-generated commands."

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 analog disc video recorder, the HS-100, that can record 30 seconds of video and play back single frames, slow motion, or backward action.

1964 or
1968 - Douglas Englegart at Stanford Research Institute invents mouse and windowing system.

1968 - Apollo 8 astronauts orbit the moon and are the first humans to the view the world as a whole and witness an Earthrise.

1968 - Doug Trumbull employs slit screen method and front projection in *2001*. The movie stars a thinking computer named HAL, who murders the crew.

1968 - *Cybernetic Serendipity* exhibition organized by Jasia Reichardt provides documentation of widespread use of computers in music, poetry, art, and animation.

1968 - Sherwood Anderson and Donald Weiner at Syracuse University create *CALD* and *CAMP* languages for the production of 2 and 3D graphics and movies.

1968 - Harvard introduces the *SYMAP* package of cartographic algorithms.

1968 - Bela Julesz and Carol Bosche make random dot computer animated stereo movies demonstrating cyclopian perception.

1968 - Hewlett-Packard introduces the 9100A, a $4900 desktop calculator that could perform basic arithmetic, transcendental functions, log functions and trig functions.

1968 - Gordon Moore and Robert Noyce found Intel Corp.

1968 - Ivan Sutherland builds a head mounted display with individual monitors for each eye and a position tracker that enables a computer to update the views based upon where the subject is working. This is one of the first virtual reality systems.

1968 - Doublas Englebart demonstrates collaborative work on a hypertext document between two individuals 500 miles apart.

1969 - McLaren uses strobes in *Pas de Deux*.

1969 - Ronald Baecker creates *GENESYS*, an interactive picture driven animation language that incorporates freehand sketching of objects and motion pathways, interactive playback, and a way to edit objects and pathways.

1969 - ARPANET comes online.

1969 - Henri Gouraud develops a method of smooth shading of 3D objects that involves linear interpolation.

1970 - Chuck Csuri founds Computer Graphics Research Group at Ohio state; Nick Negroponte forms The Architecture Machine at MIT.

1970 - Knowlton composes a subroutine package/language *EXPLOR* (EXplicity Provided 2-D Patterns, Local neighborhood Operations and Randomness), which operates on a 240 x 320 x 8bit pixel matrix.

1970 - Lee Harrison's *Scanimate* system to do analogue computer animation is commercially manufactured by Computer Image Corp (CIC) in Denver. CIC makes the film *Growing*; the first customer is Dolphin Productions in NY.

1970 - William Fetter, using Boeing's First Man data base, makes a 30 second computer generated vector graphic television commercial for Norelco rasors that includes lip sync and perspective, probably a first.

1970 - Marcelli Wein and Nestor Burtnyk of the National Research Councel in Canada complement a four year old research program in interactive graphics and begin working with the National Film Board and director Peter Foldes. By the following year they complete development of a key frame language which incorporates the use of a skeleton to depict the movement between the two extreme images and the computation of interpolated in-betweens. Metadata is made as a vehicle for exploration, and their breakthrough will occur two year years thereafter.

1970 - Paik/Abe video synthesizer includes oscillators, colorizer, video feedback, mixer.

1970 - Intel introduces 1Kbit memory chip.

1971 - Intel begins marketing the 4004 chip, designed by Ted Hoff in 1969, which integrates all ALU functions onto a single chip. The 4004 has a four bit word, together with a memory chips and an I/O controller chip the computer is reduced to one board.

1971 - Stephen Beck in California builds the direct video synthesizer, which manipulates the waveform, not the image defection.

1971 - Talbot and others develop animation language, *Animator*, at MIT on interactive graphic CPU.

1971 - Hewlett-Packard announces the HP35 hand held pocket calculator. It weighs less than nine ounces and fits in a shirt picket.

1971 - IBM introduces the 5 1/2 inch floppy disc. It is used to feed control store instructions into the System 370.

1971 - Niklaus Wirth of Switzerland introduces Pascal, a programming language designed to encourage good program style.

1971 - Information International Inc. (III) debues the FR80, a high resolution grey scale microfilm camera able to record moving pictures.

1971 - Harvey Kriloff of the University of Illinois Computer Center in Chicago becomes the first chairman of the Siggraph Motion Picture Committee.

1972 - Ed Emshwiller makes *Scape-mates* on Scanimate.

1972 - Nolan Bushnell invents the video game *Pong* and founds Atari. Pong employs a one bit deep raster display and interactive response to two paddles.

1972 - Ed Catmul, at Utah, invents a *Motion Picture Language* (MOP), which consolidates the temporal domain into a single command line (not a do loop).

1972 - Newell, at Utah, implements a transparent surface rendering algorithm at Utah. that incorporates depth sorting.

1972 - Intel introduces the 8008, an 8 bit microprocessor chip.

1972 - CMX computerized editing system is introduced for on line editing. A separate system, the CMX 600 introduces the concept of non-linear editing.

1972 - In Washington, the Federal Bureau of Investigation develops a computerized fingerprint recognition system that can read up to 80 features in one-half second and then match to a database. It runs on a PDP-15.

1973 - Jack Buruess writes the program *Lunar Lander* on a PDP 11/05 and GT40 display which combines limited graphics and simulation.

1973 - Dick Shoup builds *SuperPaint*, a color video paint system (hardware and software) at Xerox PARC. This is first user friendly (interactive) raster device. Its early users include Alvy Ray Smith, in 1974, and David Em, in 1975.

1973 - Phong improves upon Gouraud shading and incorporates specular reflection.

1973 - Alan Kitchins in England develops *Antics*, a system to computer animate cels. Cels are composed of polygons attached to a skeleton which can inbetween key frames, and which can composite the cels over a background.

1973 - Foldes, Wein and Burtnyk, the NCR and NFB collaborate in what has been called "the first significant story film made with figurative computer animation. *Hunger* wins the *Prix du jury* at Cannes and becomes the first computer film nominated for an Academy Award. In order to do opaquing the algorithms output a line image and a mask, and the film is optically composited and colored.

1974 - Richard Monkhouse at the Electronic Music Studio in London builds digital video effects device.

1974 - ACM's special interest group on computer graphics, SIGGRAPH, holds its first annual conference. The organization is soon lead by Tom DeFanti, a professor at the University of Illinois at Chicago Circle, who envisions the organization as a mixture of

serious scientists, picture making gurus, artists, and the remains of the abstract video movement.

1974 - Rick Speer organizes the *First International Film Festival* in Olympia, Washington

1974 - Tom Defanti and Dan Sandin in Chicago combine Defanti's interactive real time vector graphics *GRASS* language system with Sandin's Image Processor to make real time computer animation.

1974 - Intel 8008 8 bit word chip incorporates memory, ALU, and I/O control onto a single chip. The microprocessor is born.

1974 - Ed Catmul, at NYIT, pioneers the Z buffer technique.

1975 - Paint system advancements. Smith, at NYIT, perfects *PAINT*, the first of a linage of programs including the Ampex *AVA*, and NYIT's own *Images* and *SuperPaint* systems. Shoup founds Aurora (?). David Em paints at Xerox PARC. Duane Palyka at Utah explores a variety of techniques using Jim Blinn`s *Crayon* paint program on an E&S frame buffer.

1975 - American Ed Manning constructs optical blockpix processor which works in real time.

1975 - Ed Roberts and Bill Yates of MIT design and market the Altair 8800 computer kit, which utilizes the Intel 8008 microprocessor and catalizes the personal computer industry. Students Paul Allen and Bill Gates write a BASIC interpreter to run on it and found Microsoft.

1975 - Motorola 6502 8 bit microprocessor introduced.

1975 - Seymour Cray builds the Cray-1, the fastest supercomputer on earth. It is 1,000,000 times faster than the ENIAC and 1000 times smaller.

1975 - The IBM 5100 personal computer comes packaged with an entire APL interpreter.

1976 - III, lead by John Whitney Jr. and Gary Demos, create blockpix sequence of running action for the movie *Westworld*, where

it depicts the point of view of computerized androids. III uses a high resolution color film scanner/recorder to digitize live action film, which is averaged down to a course pixel matrix before beingoutput back to film.

1976 - Craig Reynolds, at III develops *ASAS*, the actor/scriptor animation system. As an extention to LISP, and associates with each object the list of processes able to operate on it, and allows for each of these object-processors to be fully scripted timporally, or to communicate with each other as if they are all operating independently.

1976 - First network program title (*Visions/Supervisions*) made on a paint system (Xerox's *SuperPaint*).

1976 - Ampex introduces a digital video disc still store and slow motion recorder, the ESS-1. It replaces the HS-100. [also to 3]

1976 - First finite element modeling programs and first color printers introduced at Siggraph.

1976 - AT&T implements the #4 ESS switching system. It is the first successful time division pulse code modulated switching system.

1977 - Benoit Mandelbrot introduces the fractal concept and suggests it has applications in pure mathematics as well as being descriptive of nature.

1977 - Jim Blinn introduces the idea of image and texture mapping to computer graphics.

1977 - *Star Wars* becomes the biggest hit in the history of the motion picture. One small insert screen is computer animated by Larry Cuba.

1977 - Digital Effects lead by Judson Rosebush, Jeffrey Kleiser and Donald Leich create a commercial computer animation company in New York; they develop a parallel graphics notation called *Visions*, utilizing the APL language.

1977 - *CORE*, a standards definition for an interactive computer graphic system, is published by the Association of

Computing Machinery in New York. Basically *CORE* consists of standardized, device independent subroutine calls to perform activities like draw lines, specify colors, query light pen position, etc.

1977 - Steve Jobs and Steve Wozniak construct the Apple II Computer, Tandy/Radio Shack introduces the TRS-80, and Commodore the PET. All use the newer 6502 chip and require no assembly by the consumer. Gary Kildall writes an operating system for personal computers, CP/M marketed by Digital Research. Software from third parties emerge, like *Professional Composer,* a music composition program from Mark of the Unicorn.

1977 - First color raster displays introduced at Siggraph.

1978 - Dan Bricklin and Bob Frankston create *VisiCalc*, the first spreadsheet. A classical manual operation is computerized so that it looks the same; program script written by the user is embedded in the same matrix as the data, and any changes in the data or the scripts is immediatly reflected in any elements of the spreadsheet which display the result of calculations.

1978 - DEC introduces the VAX, a 32bit machine.

1978 - LeRoy Neiman demos NYIT's *Paint*, rechristened the Ampex *AVA*, during the Superbowl.

1978 - Bill Kovacks at Robert Abel's develops an animation system around E&S new picture system II. Kovacks will later found Wavefront.

1978 - Digital video effects (DVE) devices are introduced to scale and translate a moving video picture, capture freeze frames, and leave trails.

1978 - Texas Instruments introduce Speak-and-Spell, a toy that incorporates digital speech.

1979 - Alan Kay introduces Smalltalk, anticipating the graphical user interface.

1979 - Garland Stern at NYIT authors *SOFTCEL*, to simulate the ink, opaque and composition of cel animation. Ed Catmul authors *TWEEN* to in-between.

1979 - Dick Shoup publishes techniques for color table animation.

1979 - Atari 400 and 800 computers provide computer graphic and animation platforms at the low end.

1979 - Motorola 68000 16 bit word microprocessor paves the way for stand alone workstations. Sun, Apollo, and the Silicon Graphics all incorporate this chip, coupling it with AT&T's Unix OS. One of the first machines is Apollo's DN100 workstation, a 1 MIP machine indtrduced in 1981 that costs $35,000.

1980 - Tom Defanti commences The Siggraph Video Review, a video publishing seriel focused on presenting computer animation.

1980 ? - Dicomed color film render draws in vector or raster mode.

1980 - Ethernet announced by Xerox.

1980 - The Winchester disc drive, invented by IBM, is marketed by Shugart Associates for personal computers.

1981 - IBM/PC introduced, with 640x200x3 bit color graphic display and 5 1/4" floppy disk. Original models use Intel 16 bit 8086 microprocessor, a later model, the AT will use the 80286. Microsoft's MS/DOS is adoped as the operating system.

1981 - Hewlett Packard builds 32 bit word microprocessor.

1981 - Ampex introduces the ADO video special effects machine.

1981 - *Dilemma*, by John Halas, James Kass and Computer Creations uses computer controlled shape interpolation animation and records on video tape.

1981 - Turner Whitted, at Bell Labs, reinvents ray tracing.

1981 - LukasFilm computer group formed by NYIT renagades lead by Catmul and Smith.

1981 - Japanese worker Kenji Urada becomes first reported death caused by a factory robot.

1981 - Osborne Computer introduces the Osborne 1, the first portable computer. Three years later the company is bankrupt.

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

1982 - NEC Digital Video Effects (DVE) unit.

1982 - *Pac Man* is introduced.

1982 - Fractals explode in the field of computer animation. Loren Carpenter makes a short movie of fractal mountains titled *Vol Libre*. Benoit Mandelbrot publishes *The Fractal Geometry of Nature*; Mandelbrot actually introduced the fractal concept in his 1977 book *Fractals: Form, Chance and Dimension*.

1982 - *TRON*, produced by Walt Disney Productions, is first film to make extensive use of 3D computer animation. The story is also a computer theme, in which people get captured into the computer by a villaneous video game and have to fight their way back out. Animation is done by III, Abel, MAGI, and Digital Effects.

1982 - Silicon Graphics Iris fuses a pixel graphic display, display list processor and CPU into a single system, complete with a mouse, keyboard, color display screen, disc drive, Unix, and Ethernet. The system does real time interactive vector graphics and is a stand along graphics workstation/computer.

1982 - Wytek begins to offer 3D shading chips.

1983 - First CAD package for IBM PC [well, what is it.]

1983 - Garland Stern writes *BBOP*, a system for 3-D jointed figure animation.

1983 - Quantel Paintbox overcomes remaining resistant to a completely indiginous video production medium and becomes a market leader in television stations and video post production.

1983 - Bosch FGS4000 is first turnkey 3D animation system made expressely for video production facilities.

1983 - Quantel *Mirage* provides capability to image map a moving video image onto an animating grid of polygons.

1983 - First fiber-optics intercity telephone circuits operationalized by AT&T (between New York and Washington).

1983 - Number of computers on Earth passes the 13 million mark.

1983 - HP offers first personal computer with a touch screen, the HP-150.

1984 - IBM PC based paint systems introduced by Artronics, Time Arts/*Lumena*, and West End/*Brushworks* make computer painting more widely accessable.

1984 - Apple introduces the Macintosh, a fully integrated personal computer with a graphical interface that uses a mouse, windows, and integrates text and graphics.

1984 ? - Dunn and Matrix film recorders hook onto IBM PC and other workstations; they provide high resolution yet break the low price barrier, bringing slidemaking and computer animation to a wider producer base.

1984 - Cubicomp introduces a sophsicated animation software package which runs on an IBM PC-AT. It is non-real time, but it can single frame animate to either video or film recorders.

1984 - Quantel *Harry* video device provides user friendly interface to editing and compositing digital video frames.

1984 - At MIT, construction begins on *XWindows*, a graphical interface protocol for communications with interactive windows systems. It is particularly attractive to Unix users and is to Unix what the Finder is to the Mac or what Windows is to the PC.

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

1984 - Eddie Garrick directs *The Magic Egg*, a collaborative computer generated Omnimax film.

1985 - Interactive real-time turnkey animation software which runs on the Silicon Graphics' Iris workstation is introduced by Wavefront, Alias, and others, and finds applications in video as well as film production.

1985 - Commodore Amiga is introduced.

1985 - AT&T introduces the Targa board, a color graphics frame buffer card which plugs into an IBM/PC and can output legal video. It both extends the graphics range of the PC and enables animation production onto video tape using this platform.

1985 - A company founded by John Warnock called Adobe introduces a page description language called *Postscript*. The Postscript commands are interpreted by a cpu inside of a new generation of electro-static laser printers.

1985 - *Graphics Kernal System (GKS)* addopted; it is another graphical standard, originating in Europe in the late 1970s, similar to *CORE* but focused on the programmable refresh display.

1985 - Versatec introduces the electrostatic color plotter.

1985 - Number of personal computers in United States exceedes 9 million.

1986 - *Renderman* standard is proposed by Pixar as an interface protocol between temporal gemotry data and rendering procedures which convert the data into images.

1986 - *PHIGS* is introduced, it is a ????

1986 - Compaq introduces first personal computers using Intel 80386 32bit CPUs.

1986 - Nintendo introduced and the video games market experiences its second boom.

1987 - DEC introduces desktop VAX.

1987 - Apple introduces Mac II and the object oriented language *HyperTalk*, used for programming graphical interfaces.

1988 - First micromoter, .0001 inch across, is fabricated at the University of California at Berkeley.

1988 - First public demonstrations of virtual reality environments at Siggraph.

1989 - Pixar's *Tin Toy* is first computer animation to win Academy Award for Best Animated Short Film.

l989 - Pacific Data Images creates computer animated character which is controlled in real time by a mcehanical armature fitted to a human hand.

1989 - First multimedia demonstrations at Siggraph, including Dick Philips demonstration of conference proceedings and Pacific Interface HyperCard controlled videodisc.

1990 - Microsoft begins shipping *Windows 3.0,* a graphical user interface for MS/DOS and the IBM/PC platform.

1991 - Industrial Light and Magic produces a simulated liquid metal antogonist for the movie *Terminator 2* which establishes computer animation as a seemless extention to live action.

1991 - The German company Heidelberg introduces a direct digital color printing press. It works by burning plates already mounted on the press. The plates are composed of silicone, aluminum, and a polymer and are pitted with an electrical spark.

l9xx - ALGOL, a model for the Pascal language, sets the pace as a formal, proveable language, more constrained than Fortran.

l9xx - Bell Telephone Labs published the C language and Unix operating system for mini-computers. C resembles Fortran, but has the advantage of extended and mixed data types, including a pointer.

Unix, which is written in C, becomes the first portable operating system.

19xx - III makes shots for feature film *Looker*

1930s - Camera rostrum aka the animation stand.

I950s - Oxberry automated optical printer.

- Solarization

- Animascope by Leon H. Maurer and Harry Wuest combines photographed actors, dressed as cartoon characters, with backgrounds.

- Paint on glass

- Compass used to make circles and assist in geometric constructions.

- proportional dividers

- Romans imploy ink drawing pen.

19?? - Jay Ward's *Crusader Rabbit* is the first animated cartoon series on television. Later, in the 1950s, Ward, along with Bill Scott will introduce *Rocky and Bullwinkle.*

19?? - steel ribbon tape is introduced for measuring distances.

19?? - Winky Dink introduces the idea of interactive TV. It consists of a plastic sheet you place over the TV monitor, a crayon you draw with, and an interaction, such as connect-the-dots, to form a picture. Some horrified mothers forbid their children this luxury fearing they may draw on the TV set by mistake.

19?? - Bouncing ball animation in the silent cinema provides a rhythm beat for live music.

19?? - Richard Feynman theorizes it is possible to fit all human knowledge (24 million books) in a volume the size of a dust mote using a binary code of atoms aranged in a serial string.

19xx - J. W. Tukey coins the term bits, or binary digits.

1946 - ?? Denning applies statistical analysis to quality control aspects of the manufacturing process and receives wide acceptance in Japan. He is ignored by American business.