

WHAT IS IT?

(And how do you slice it and dice it?)

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What is it and how do slice and dice it?

“It” is colorless, odorless and tasteless. It is neither animal, vegetable nor mineral. It can be divided but not added, subtracted or multiplied. We use it every day and have a definite amount but we don't know how much. It can be spent but not saved. We consider it to be linear but under special circumstances can be curved. No one has ever seen it or heard it but it is there. By now you must have figured out we are talking about the mysterious fourth dimension – time. St. Augustine once said, “What is time? Who can even in thought comprehend it, so as to utter a word about it? If no one asks me, I know: If I wish to explain it to one that asks, I know not”. Since it is one of the deepest mysteries known to man and no one can say exactly what it is, still the measurement of time makes man's way of life possible. Without time a timeless world would be at a standstill but if some kind of change took place, the timeless world would be different now than it was before. So time and change are related. Some changes only take place once while others happen over and over again. When early man began to notice repetitive changes in his environment, he began to measure time. The most obvious were in the sky which came in cycles, day and night, the shape of the moon over a month of 29.5 days, and the cycle of the seasons. Ancient civilizations depended on the apparent motion of the celestial bodies through the sky. Every culture had people who were preoccupied with measuring and recording the passage of time. Five thousand years ago Sumerians in the Tigris-Euphrates valley devised a calendar which divided the year into 12 - 30 day months, day and night into 12 parts each, an hour into 60 minutes and a minute into 60 seconds. They also divided a circle into 360 degrees. The earliest Egyptian calendars were based on cycles of the moon as many others since have been, but later they realized that the Dog Star, Sirius, rose next to the sun every 365 days about the time the yearly Nile floods began and around 3100 BC they devised a 365 day calendar. The Babylonians around 2000 BC used a year of 12 alternating 29 and 30 day lunar months which gave a 354 day year, while the Maya of Central America relied not only on the sun and moon but also Venus to establish 260 and 365 day calendars. They left celestial-cycle records indicating that the creation of the world occurred in 3114 BC. Later, their calendars became part of the great Aztec calendar stones. Stonehenge on Salisbury plain in England was thought to have been designed to indicate the date of the summer solstice

when the heel stone, rising sun and altar stone were in alignment as well as other solar and lunar cycle events. Modern day Druids, a rather motley crew if I do say so, still congregate there on Midsummer's Eve to party all night and watch the sun come up the following morning, among other activities.

Calendars are usually based on astronomical events and the most important objects of course are the sun and the moon whose cycles are observable. One concept of a year is based on the earth's rotation around the sun and the time from one fixed point such as a solstice or equinox. Its current length is 365.242190 days but it varies slightly and is called a tropical year. Our concept of a month is based on the moon's motion around the earth although it is not exact and the time from one new moon to another is called a synodic month, currently 29.5305889 days. These are averages and so in any particular year may vary by several minutes due to the influence of gravitational force from other planets. Similarly, the time between two new moons may vary due to the gravitational force from the sun and the moon's orbital inclination. Obviously the two are out of sync and 19 tropical years equal 234.997 months. This 19 year cycle is called the Metonic cycle. Directly above every spot on earth is an imaginary curved line. As the earth rotates on its axis, the sun crosses every celestial meridian once each day, and the time there is noon. From one to the next is divided into 24 hours. This rotational time is based on the unit of the mean solar day. A second way is Dynamic time which uses the motion of the moon and planets to avoid variations in the earth's rotation and Ephemeris Time is an example. Atomic time is a third way and we will go into that later on in this paper.

The Chinese calendar has 29 or 30 day months and extra months are added at regular intervals to make up the difference. The years are also arranged in twelve year cycles. Each year is named after an animal and 2004 was the year of the Monkey while 2005 is the year of the Rooster. The year of birth has astrological significance and man born in the Year of the Sheep might not want to marry a woman born in the Year of the Snake. Chinese New Year is celebrated on the second new moon after the winter solstice and will fall on January 22nd in 2005. The year 2005 in our Gregorian calendar will be 4702 – 4703 in the Chinese. The Hindu calendar is of much more recent origin and is based on

both lunar and solar years. Introduced in 1957, it was designed to push all of India into one calendar. Years start on March 22 Western time and in 2005 will be 1926-1927 with the first year of the Saka era, AD 78 used as the reference point. The Jewish year 5765-5766 corresponds to 2005 and is both solar and lunar based with leap years and intercalary months as needed. Although Nisan is considered the first month, Rosh Hashanah which falls on the first of Tishri, the seventh month, is considered New Year Day. The Islamic calendar is based on a lunar year of 354 days with adjustments and our year 2005 is 1425-1426 in their system, dating back to 622AD, the year Muhammad emigrated from Mecca to Medina. Julius Caesar wished to have one calendar for the entire Roman Empire and had the astronomer Sosignes to develop a uniform solar calendar with a 365 day year, and the first of the year was moved from March 21st to January 1st. This failed to reckon with the extra $\frac{1}{4}$ day per year, and the Gregorian calendar was introduced in 1582 to realign Easter with the vernal equinox by adding a leap year that added an extra day every four years. Much of the western world followed that scheme except England and the American colonies who started their year on March 25th intended to represent the spring equinox. In 1752, the English government joined the rest of the world by making January 1st the year's beginning. Having pretty well exhausted your attention span on calendars, lets go on to weeks which Christian, Jewish, Islamic, Persians and Chinese calendars all agree have seven days, no small feat in itself. In the Genesis creation story, we read that God created the Earth in six days and rested on the seventh but some civilizations arrived at other arrangements. The Ancient Egyptians had a ten day week as did the French during the Revolution, the Russians experimented with five and six day weeks before going to a seven day week in 1940 and the Mayas had both a 13 and a 20 day week.

Most Latin-based languages connect each day of the week with one of the seven heavenly bodies of ancient times – Lundi = Moon, Mardi = Mars, Mercredi = Mercury, Jeudi = Jupiter, Vendredi = Venus and Samedi = Saturn. Another connection which Jim Love would appreciate is that the number 7, a perfect number in the bible, also applies to the number of beer cans which encircled with a rubber band will maintain their geometric symmetry without shifting. I'm not sure that the ancients were aware of that particular

factoid. The English days are a combination with Tuesday through Friday named for the old Norse Gods Tiu, Woden, Thor and Freya also known as Frigg, the goddess of love and fertility. The names of the months come from the Romans. January from Janus the two faced God, February from the Latin “to cleanse”, the month the Romans purged themselves from sin (and later the beginning of Lent). March for Mars, April means to open, the month the flowers start blooming, May after the goddess Maia and June after Juno. The two Caesars came next, Julius and Augustus, followed by the numbered months seven through ten which were in that order in a previous calendar before the Caesars names were interjected. Time measurement is another story.

To determine shorter intervals of time, like periods during the day, the ancients began by using sundials, and although the Sumerians didn't pass on their knowledge, the Egyptians built obelisks and their moving shadows formed a kind of sundial which partitioned the day into morning and afternoon and also showed the longest and shortest days of the year by shadow length. Later additional markers around the base indicated smaller divisions. Another Egyptian shadow clock came into use around 1500 BC which divided the sunlit day into 10 parts plus two twilight hours in the morning and evening. It was semi-portable, a first. In about 600 BC, the first device for measuring night-time hours was devised by the Egyptians. It utilized two merkhets which established a north-south line and by aligning them with Polaris, could mark off the nighttime hours by determining when certain other stars crossed the meridian. Sundials evolved from flat horizontal plates to more elaborate designs and by 30 BC, one Roman described 13 different types in use on Greece, Italy and Asia Minor. Early other processes were candles marked in increments, oil lamps with measured reservoirs, hour glasses, and knotted cords. Water clocks were an early development which didn't depend on the sun, and one was found in the tomb of Pharaoh Amenhotep I who was buried around 1500 BC. The Greeks started using them around 325 BC and called them clepsydras, which were made of stone with sloping sides, with a small opening which flowed into a bowl shaped container with markings on the inside surfaces. More elaborate mechanized varieties were developed by the Greek and Roman astronomers, and some rang bells and gongs, opened doors to show

figures of people or moving pointers and dials. The Horologion which is known today as the Tower of the Winds in the Athenian Agora was built in the first century BC and had both mechanical and sundial indicators. It had indicators for the eight winds and displayed the seasons of the year and astrological models of the universe. In the Far East, Chinese inventor Su Sung made a water clock tower over 30 feet tall which was very elaborate with a rotating celestial globe, bells and gongs rung by manikins and tablets indicating the hour or other times of day. In the first half of the 14th century the first mechanical clocks began to appear in the towers of several large Italian cities which were weight-driven and regulated by a verge-and-foliot mechanism but were difficult to regulate. Those in Orvieto (1307), Ragusa (1322), Milan (1336) and Padua (1344) were early examples. The oldest still existent tower clock is in Salisbury Cathedral, England, dating back to 1382 and which rang on the hour while the Clock in Rouen , France, dated shortly after, (1389) rang on the quarter-hour. Tower clocks continued to proliferate in Europe, with many added features including figurines which came out of trap doors to musical accompaniment, a good example still there today is in the old town clock of Rothenburg, Germany, which has preserved its old walled character. The use of a spring instead of a weight was in use by 1430 and was a real advance. Cuckoo clocks were born in the Black Forrest in the 1800's and continue to be popular tourist items. In the United States, Town Clocks had their heyday after the Civil War. Probably the most famous tower clock of course is Big Ben, located in the St. Stephen's Tower of the Parliament buildings in London. Originally the name was given to the 5 ½ ton bell but later was applied to the clock and tower. It was constructed in 1869 after fire destroyed the old structure. Smaller clocks and even watches tended to slow down as the mainspring unwound but were a real advance. Most were square boxes made of metal with the dial on the top side and affordable by only the rich. Galileo devised the Pendulum concept but it was Huygens, a Dutch Scientist, who actually constructed a clock using that mechanism in 1655 which was accurate to less than ten seconds a day. Twenty years later, he developed the balance wheel and spring assembly which is still found today in some wrist watches. The minute hand was added around 1690 and the first Watchmaker guilds were being formed. The Eighteenth century saw many improvements including jewels which were used for bearings, better escape mechanisms, accurate Marine

Chronometers, second-hands, and the helical balance spring. Abraham Brequet made many important changes and added a gravity compensating mechanism, temperature compensation and utilized self-winding. There were a number of New England Clock Makers who used wooden movements and from the pack emerged Seth Thomas who started into business after serving an apprenticeship. He produced his first shelf clock in 1817 and in 1842 produced clocks with brass movements. After his death in 1859 the company continued until 1930 when it joined General Time Instruments and was later purchased by Talley Instruments and moved to Norcross, Ga. Many of the homes of our grandparents had a Seth Thomas sitting on the mantle over the fireplace. Banjo clocks actually date back to a patent issued to Simon Billard in 1802, with the distinctive shape of a round face, a long throat and rectangular box. They also have a cult following at present. There were further refinements over the next 100 years and the Shortt Clock in 1921 used a double-pendulum movement that was the standard for most observatories, and accurate to less than one hundredth of a second per day. Crown winding was developed by Louis Audemas in 1837 and was to replace the old key winding method. The Swiss entered the picture in the 19th Century and several of the world premium watches of today such as Jaeger-LeCoultre, Patek-Philippe, Eterna, Tag Heur and Breitling had their founding then. Perpetual calendars, moon phases, and other refinements came with time. Rolex actually was started in London by Hans Wildorf but moved to Geneva in 1919, has become a symbol of wealth and success. It has also engendered many cheap counterfeits which you can buy on many a third-world street corner. They now have 3000 employees and have produced 10 million watches. Omega, another premium watch, dates back to 1894 although the first watches carrying the Omega name were produced in 1903. An Omega Speedmaster was worn by Neil Armstrong when he first set foot on the moon on July 21, 1969. The Competition between various watch makers grew and Observatories issued certificates of accuracy which were points of pride. Even today the COSC, Control Official Swiss des Chronometres, certifies the accuracy of movements and to rate the best is like winning the Super Bowl. Wrist watches originated in the early 20th century and at first were resisted by the Swiss because of the problems of dirt, shock, shock and humidity, but they entered the game in order to survive. U. S. Industrial watchmakers started around 1840.

Waltham watches started under the name of American Horology Company through a series of name changes and a bankruptcy or two and Abraham Lincoln carried their "William Ellory" model in 1863. Elgin lasted from 1864 until the late 1960's but by then had turned out 60 million watches. Joseph Bulova, a Czech immigrant came to New York City and opened his company in 1875, but moved operations to Switzerland in 1912. His company produced the first clock radio in 1928, an electric clock in 1931, the alarm watch in 1953, and the Accutron model which first utilized a tuning fork. Timex is the ultimate American example of entrepreneurship. Started in Waterbury, CT., it was known at the Waterbury Company and also manufactured shelf and mantle clocks. In 1900 they produced the famous "Yankee" model pocket watch which sold for \$ 1.00 and that's where the term dollar watch originated . They also made the Mickey Mouse watch in 1933 in collaboration with Walt Disney and an original is a real collectors now item. The company name was changed to U.S. Time Company in 1940 and the first Timex under that name was marketed in 1950. An extensive Radio and TV campaign resulted in universal name recognition and as of now more than 500 million Timex watches have been sold. ^{Addendum to Time} You may remember, at least you older members might, when passenger trains came through Hopkinsville. The conductor wore a blue suit, hat and a vest. He always carried a pocket watch with a chain that most of the time had a Masonic Emblem dangling from it. The Railroad Standard Watch which he carried dated back to the 1890's and they were known for their accuracy. It seems there was a fatal railroad accident in 1891 was blamed on a watch which was several minutes off , so in 1893 the general railroad timepiece was developed and it was known for being correct.

The next improvement in accuracy resulted when Quartz clocks were developed beginning in the 1920's. When an electrical field is applied to a Quartz crystal, the crystal changes its shape and will generate an electrical field, the so called piezo-electrical effect, When placed in an electronic circuit, the interaction between mechanical stress and electrical field causes the crystal to vibrate and generate an electrical signal of relatively constant frequency that can be used to indicate time intervals. Because of their stability, crystals have been used in radios for years in electronic circuitry. They continue to dominate the market because their performance is

excellent for the price. Currently the most accurate clocks are so called atomic Clocks based on the natural frequency of the Cesium atom. Each chemical element and compound absorbs and emits electromagnetic radiation at its own characteristic frequency. which is stable over time and space. Thus atoms constitute a potential “pendulum” with a reproducible rate which is the basis for increased accuracy. The development of ultra and very high frequency microwaves made it possible to interact with the ammonia molecule and was used to construct the first atomic clock in 1949. When that proved not much more accurate than the existing standards, attention was focused on atomic beam devices based on Cesium, Atomic number 55, atomic weight 133. Work at the National Physical Laboratory in England in collaboration with the U. S. Naval Observatory resulted in establishment of the frequency of Cesium as referenced to astronomical time in 1955 and by 1960 the standards had been refined enough to be incorporated into the official timekeeping system of the National Institute of Science and Technology. In 1967, the Cesium atoms natural frequency was recognized as the new international unit of time. The second was defined as exactly 9,192,631,770 oscillations of the atoms resonant frequency, replacing the old second that was defined in terms of the Earth’s motions. The latest NIST clock is accurate to 30 billionths of a second per year. This is fine but I imagine most of us would be happy if our wives were accurate to within 30 minutes of a projected departure time from home to go anywhere, except for a shopping excursion to Nashville perhaps.

When the need for a standard time arose in railroad transportation in the UK the Brits established a railway standard time in 1852 with the Royal Observatory in Greenwich, England as time keeper, and time was transmitted telegraphically to the system. In the United States, the Railroads divided the country into four standard time zones, each centered on a meridian of longitude 15 degrees apart, with the eastern zone on 75, the central 90, etc. An international conference in 1884 met in Washington, DC established world-wide time zones with the prime meridian passing through the Greenwich Observatory chosen as the starting point. Quite obviously if the world has a circumference of 25,000 miles, a circle has 360 degrees and there are 24 hours to each day, a distance of 15 degrees would equal one hour. The world was divided into 23 full

and two half zones which lie adjacent to one another 180 degrees away from Greenwich and separated by an imaginary line called the International Date Line. A traveler going from east to west loses a day, while one going from west to east gains a day. Thus so called GMT or Greenwich Mean Time was established and recognized as the world standard for time. It was based on the earth's motion which fluctuates, so in 1972, a more accurate scale was developed called Coordinated Universal Time abbreviated as UTC, which runs at the rate of the atomic clocks. Both the U.S. National Institute of Science and Technology based in Ft .Collins, Colorado, and the U.S. Naval Observatory in Washington contribute data to the International Bureau of Weights and Measures in Paris which coordinates input from more than 25 countries. To see a clock synchronized to official U. S. Government time, go to <http://www.time.gov> on the Internet, or if you have a multi-band radio receiver you can hear the minutes announced on several frequencies such as 2.5, 5.0 and 10.0 Megahertz from WWV, the NIST transmitter. You might even have an "Atomic Clock" in your home which has a built-in radio receiver tuned on WWV and corrects itself every morning around 1:30 am. Sometimes synchronization can be a problem. In earlier times, Jewelry Stores had clocks in their windows. In one industrial town, the owner noted that a man would stop each morning at 7:45 and set his pocket watch with the clock in the window. Becoming curious, he stopped the man to ask why he was doing this. The man said " Well, I work at the local plant and blow the whistle every morning at 8 O'clock sharp. Oh by the way, how do you set your clock." The Jeweler laughed and said, " Every morning I set my clock at exactly 8:00 when the plant whistle blows." In Ham Radio, we use UTC time so when it is one minute after midnight at Greenwich and 6.01 pm central standard time in Hopkinsville, we would log a contacted station in at 0001 hours Military time, of course, is also on a 24 hour basis. We won't go in to Daylight Saving Time for sake of brevity.

William Turner would be disappointed if we didn't include the Hopkinsville connection, so here goes. The Old Fire Station and Town Clock only date back to the 1920's. A previous fire Station burned down in 1924 and was replaced by the present building. The Clock Tower was added by the City in 1926 at a cost of \$ 4000 and the Woman's Club raised \$ 2000 to buy the Clock which was placed into operation in January 1927. It did