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The Literary Club

It's About Time
by
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According to my watch, it is now 8: PM, Coordinated Universal Time. It was now a few minutes ago when our president convened the meeting. It will also be now when I finish reading this paper. We call the intervals between the nows "time".

We can do a lot of things with time. We can save it or spend it, find it or lose it, borrow it, waste it, take it, even steal it. Sometimes we have a lot of time. Sometimes we don't have any. Some people make time, others sell it. Sometimes those who steal time, do time.

But we can't see it, hear it, feel it, taste it or smell it. And we really don't know what it is.

Asked about time, the philosopher Ludwig Wittgenstein, said, "If no-one asks me, I know;…(but) if someone asks me to explain it, I don't know". The same comment is sometimes attributed to St. Augustine two millennia earlier.

So what do we know?

Is time simply a concept devised by man to calibrate his journey through life, or does it have independent existence? Is it some form of energy, an invisible, unfelt force that moves us forward from day to day, from birth to death? Can it speed up or slow down? Flow backward? Is it infinite? If not, how and when did it start, and how and when will it end?

Scientists, philosophers and poets have pondered these questions for ages, but, like Wittgenstein, and/or St. Augustine, they don't know.

Nevertheless, time has always been part of man's experience. Man recorded time long before he started recording history. Twenty thousand years ago, ice age hunters in Europe scratched lines and gouged holes in bones, apparently to keep track of the days between the phases of the moon.

Five thousand years ago, Sumerians in the Tigris-Euphrates valley created a time-keeping system quite parallel to ours, with a 30-month year, days divided into 12 segments instead of our 24 hours, with each segment divided into 30 parts, each equal to four minutes of our time. The Egyptians, Babylonians, Mayas and Aztecs all had time systems based on the movements of celestial bodies.

According to Greek mythology, time was originally the property of the god Uranus, whose children were the seven then-visible planets. Hearing that one of them planned to kill him, Uranus slaughtered all of them. At least he thought he had. Their mother, Gaia, managed to hide one son, Kronos. When Kronos reached maturity, he castrated Uranus and killed him and then married Rhea, another sister of Uranus. Then Kronos heard that his children were planning to kill him, so he ate them. Except that Rhea managed to hide Zeus, who then castrated and killed Kronos, and then, time belonged to Zeus.

The happy ending to this tale is that Zeus gave time to man. But he wisely made man mortal, so our children don't have to commit murder to get rid of us.

Most ancient philosophers and cultures believed that time is infinite and eternal, except Judaeo-Christian creationism. Old Testament Genesis is wholly time-oriented:

> *"In the beginning God created the heaven and the earth…*
> *And God called the light Day, and the darkness he called*
> *Night…And the evening and the morning were the first day…"*

and so on for seven days and nights.

According to St. Augustine, time was a property of the universe, and since God created the universe, time began at the moment of the creation. James Ussher, a 17th century Irish bishop, counted up all the biblical "begats" and "begots" and determined that the universe was created and time began on October 22, 4004 B.C.

What happened on October 21, he didn't say. And in 1951, the Catholic Church officially declared that the "Big Bang" and the simultaneous beginning of time were biblically accurate.

Your watch may disagree with mine by a minute or two, but we agree that Cincinnati time is always the same as New York time, one hour earlier in Chicago, two hours in Denver, and so on around the world's 24 time zones.

But the clock didn't always start from a uniform prime meridian and march around the globe in 24 one-hour strides, and there hasn't always been only one line from which everyone starts counting.

Before the late 19th century, daily activities throughout the world were governed pretty much the same way they had been for the previous 20,000 years. Each community kept its own clock and its own prime meridian based on the movement of the sun. However, since the earth revolves from west to east on its polar axis at the rate of about 750 miles per hour, or twelve and one-half miles a minute, every twelve and a half miles east or west of any point is a solar minute later or earlier.

On December 31, 1849, when the clock struck midnight in New York City, it was 11:55 in Philadelphia, 10:45 in Chicago, and 9:00 P.M. in San Francisco.

In Cincinnati, if the members of The Literary Club had gathered to observe their first New Year, they would have popped their corks 45 minutes after the New Yorkers did.

In 1850 there were 144 North American time zones, each determined by the rhythm of the sun. But as long as people stayed for the most part in their own communities, and horses and boats were the principal means of transportation, uncoordinated time standards didn't matter. No one could travel far enough or fast enough to be inconvenienced by differing clock times.

The railroads were the first industry to have a commercial interest in time. By the 1870's, improvements in technology made rail the dominant means of long distance ground transportation for most of the world. Trains could easily travel 100 miles in two hours or less. A train leaving Town A at noon, Town A time, traveling 50 miles an hour, would arrive at Town B, 100 miles away at 2 o'clock, Town A’s time. But its arrival time in Town B would be 2:08 or 1:52, depending on whether the train had traveled east or west.

Instead of dealing with these discrepancies, each railroad used the time at its company headquarters as the time for its entire system. The Pennsylvania Railroad ran on Philadelphia time, New York Central ran on “Vanderbilt time”, the time at Grand Central Station, and so forth.

A Philadelphia passenger traveling to Buffalo with a change of trains at Pittsburgh would know that an 8AM departure time on his schedule was based on Philadelphia time, provided that he was traveling on the Pennsylvania Railroad. If it was the New York Central, his Philadelphia departure time would be 8:05AM.

Pittsburgh time was 20 minutes earlier than Philadelphia time, but the train from Pittsburgh to Buffalo originated in Columbus, Ohio, where the time was 12 minutes earlier than Pittsburgh and 32 minutes earlier than Philadelphia. A train from Philadelphia would arrive at Pittsburgh at 5 o’clock, Philadelphia time, but it would be 4:40, Pittsburgh time. The train from Columbus that arrived in Pittsburgh at 4:40, Pittsburgh time, arrived, according to its Columbus schedule, at 4:28.

Confused? Pity the poor passenger, who had to figure it out on his own.

In England, which adopted nationwide standard time in 1833, Oscar Wilde observed that the chief occupation of American life was “catching trains”.

In the 1880’s, the telephone, electric light, typewriter, motion pictures and high-speed stop-action photography were developed. Assembly lines began replacing natural work habits, and the conflict between solar time and technology went from mere inconvenience to costly inefficiency.

By that time, most European nations had already adopted single national time standards, but centuries of constant conflict among them mandated that each continue to use its own prime meridian and other barriers against intrusion; and when rail became the fastest means of ground travel, each created its own rail system, with incompatible track gauges and couplers to prevent their enemies from invading by simply riding the rails.

At the same time, world-wide maritime commerce was expanding rapidly, but was hampered by distressed ships of different nations that often were unable to communicate their positions to the nearest points of rescue because they navigated with different charts and prime meridians.

Back in North America, local time areas began converting to the zones of nearby mercantile and industrial centers. Connecticut converted to New York City time. A "Chicagoland" zone developed in the tri-state area around the Windy City.

Yet, at the beginning of the 1880's there were still 44 North American time zones.

Finally, in November, 1833, the railroads consolidated their then 50 railroad times into four zones, Eastern, Central, Mountain and Pacific, the same names, but not quite the same zones that we have today. Within days after the change became effective, 75% of the schools, courts and governments adopted the same four as their official zones.

In 1880, a presidential election year, the Republican party chose James A. Garfield as their candidate to succeed the somewhat disgraced Rutherford B. Hayes. But at that time, the vice-presidency was not considered an important office, and it was not uncommon for party leaders to run unknowns, who would not get in their way. Like Chester A. Arthur.

Prior to that time, the only public office Arthur ever held was Collector of the Port of New York. In addition, he was a widower, and there were rumors as to his sexual preferences. He was the perfect candidate for vice president, and the Garfield/Arthur team was elected.

But they had disregarded Robert Burns' caveat that *"the best-laid schemes o' mice an' men gang aft agley"*; and five months later, Garfield was assassinated, and, lo and behold, Arthur became president.

Fortunately, Arthur knew he didn't know what he was doing, and didn't much care. He simply retained Garfield's cabinet and let them run the government and push Garfield's agenda, while he spent the remaining 43 months of Garfield's term socializing with Washington high society, always dressed in white from head to toe.

But despite history generally giving him bad marks, a few kinder historians believe he should at least be given a pat on the back for his help in resolving the prime meridian stalemate.

In December, 1883, Arthur sent a letter to the leaders of the then 25 other so-called "civilized" nations of the world urging them to send delegates to a conference to be held in Washington the following October for the sole purpose of resolving the prime meridian problem.

The Global Prime Meridian Conference began on October 1, 1884, with 24 nations plus the United States in attendance. Only Denmark failed to attend. Arthur opened the conference with a speech emphasizing the importance of the issues, and asked the delegates not to leave until they were resolved.

The delegates quickly and unanimously passed a one sentence resolution approving the adoption of a single prime for all nations, and spent the next three weeks arguing about where it should be placed.

By then, the Observatory at Greenwich, England, had become the navigational prime meridian for most of the maritime nations, and was the obvious, but not unanimous favorite. There were some sentimental and historic favorites, such as Galileo's Pisa and Egypt's Great Pyramid, and a few smaller nations which had already established their own prime proposed that it be extended to serve the entire world. But there were only three real contenders – Greenwich, Paris, and a "nether arc", or "anti-prime" running through the Pacific Ocean, as a non-political compromise.

After three weeks of debate, on October 22, 1884, exactly 5,888 years after time began according to Bishop Ussher, Greenwich won.

They then sliced the world into 24 longitudinal wedges of 15 degrees each, 12 running 180 degrees east and 12 running 180 degrees west, to avoid Greenwich being at longitudes zero and 360 simultaneously, placed the International Date Line in the Pacific at the 180 degree "anti-prime" to start the universal day, and the conference was adjourned.

Within weeks, all of the participating nations except France ratified the conference actions. Finally, in 1898, France re-defined its official time as "Paris mean time, less nine minutes, twenty-one seconds," making it identical to Greenwich Mean Time.

In the end, France had its way. In 1963, Coordinated Universal Time, which was developed by the French, replaced Greenwich Mean Time as the standard everywhere in the world, except Britain. The difference between the two is less than one second a day, but Coordinated Universal Time compensates for the earth's decelerating rotation, and is the more precise measurement.

And that's how things stand today.

But all of this has to do with terrestrial time, non-cosmic clock time here on Earth. Cosmic time is another matter.

The first scientific model for cosmic time was proposed by Isaac Newton in 1687, in his treatise, *"Mathematical Principles of Natural Philosophy"*, one of the most important works ever published on the physical sciences. Contrary to the biblical view, Newton said that the universe as well as time and space, were infinite. But his time was a line that flowed endlessly without reference to anything external, ticking off identical intervals of seconds, minutes, hours, days and years forever.

Newton's absolute time is the comfortable, common sense, intuitive time of our everyday experience, the time of day, the time it takes to get from here to there, the time that flows inexorably forward as we age. As long as we all use accurate clocks, we will always agree on the time. We won't know what it is, but we'll agree on it.

Over the decades, Newton's laws led to the unraveling of most of the mysteries of the physical world – electricity, magnetism, gases, optics, acoustics, kinetics, X-ray, the electron and radioactivity, and the invention of the ohm, the watt, the Kelvin, the amp and the joule. We still use Newtonian physics today for all practical purposes, because whatever flaws it has are not significant for purposes of our day-to-day requirements.

But there are flaws. They started to become apparent in 1905, when Albert Einstein, then a 26 year-old Swiss Patent Office employee, published his article, *"On the Electromagnetics of Moving Bodies"*. Using the word "know" in its very loosest sense, we know that it was the article that explained his Special Theory of Relativity, formulating the equation $E=mc^2$ - energy equals mass multiplied by the speed of light squared. In its simplest terms, it means that energy and mass are different forms of the same thing: energy is liberated matter, and matter is energy waiting to happen. Since "c" – the speed of light – squared is an enormous number, it tells us that a huge amount of energy is bound up in the smallest bit of matter. The power produced by converting a tiny bit of uranium into energy destroyed Hiroshima and incinerated 100,000 human beings in a few seconds. The matter in an average adult contains enough potential energy to produce about 30 large hydrogen bombs.

Einstein refined and clarified his Special Theory in 1916, when he published his General Theory of Relativity. It explains that one-dimensional time and three-dimensional space are actually components of a single four-dimensional space-time continuum, warped and curved by the matter and energy in it. Subsequent research and experimentation have confirmed these theories, and building on them, later generations of scientists have determined that, rather than being infinite, as Newton proposed, the universe began approximately 13.7 billion years ago with the "Big Bang", that inexplicable instant when all energy and matter in our universe suddenly burst forth from a single infinitely dense mass and started expanding. And a Planck era after that, that is, 10 to the minus 43rd power fraction of a second later, time began.

According to Einstein, time is relative. It slows down as speed or gravitational pull accelerates, and speeds up as they decelerate. Each person traveling his or her own way experiences time differently than others traveling differently. Expensive watches worn by two friends who start at the same time and place will start ticking off time at different rates as they move apart at different speeds or into different gravitational fields. The more out of sync the watches fall, the more these factors will come into play. They might argue about whose fancy watch is wrong, but both will be correct, demonstrating that time is in the eye of the beholder.

A plane that leaves San Francisco flying east for 2030 miles at an average ground speed of 450 miles per hour will reach Cincinnati in four hours and 30 minutes. Atomic clocks in San Francisco and Cincinnati will confirm the accuracy of that amount of time. But an atomic clock aboard the plane will show that the eastbound flight took a few milliseconds less. In other words, time aboard the moving aircraft had slowed down, and the seconds ticked more slowly on its clock than they did on the stationary clocks.

Had the plane flown west from Cincinnati to San Francisco, its clock would have shown that the flight took a few milliseconds longer than the time shown on the stationary clocks.

Why? Because under the laws of relativity, all objects in the universe are in motion, including all of us in this room. At our latitude, the earth rotates from west to east at 750 miles per hour, taking all of us and my theoretical plane along with it. The eastbound plane actually travels 1,200 miles per hour, carried, along with the rest of us, at 750 miles per hour by the earth's momentum, plus an additional 450 miles per hour on its own power. The westbound plane also travels 450 miles per hour on its own power. but is held back by the earth's 750 mile per hour momentum, making its net westward speed 300 miles per hour. Accordingly, time aboard the slower plane speeds up compared to time at our relatively faster-moving Literary Club.

The standard scientific description of this phenomenon is called "the Twins Paradox". One twin leaves on a space journey, speeding away from earth for six months at 99.99% of the speed of light, and returns over the following six months at the same speed. The traveling twin's speed will slow his internal clock relative to that of the stationary twin so much, that upon his return, the traveling twin will be one year older, but the stay-at-home twin will be 7,000 years older. If the traveling twin had hovered above a black hole, with a mass 1,000 times stronger and a gravitational field correspondingly stronger than that of our sun, upon his return, one year later on his clock, more than a million years would have elapsed on earth.

H. G. Wells imagined this phenomenon 10 years before Einstein in his 1895 novel "The Time Machine". An unnamed Time Traveler speeds off in his invention in the morning, lands 30 million years in the future, and returns home the same evening to relate his adventures to his dinner partners. Wells was sort of on the right track. Assuming the Traveler was traveling near the speed of light, on his own internal clock, he could have flown about 10 years into the future and returned home that evening without aging significantly. But his dinner partners would have been waiting 10 years for his return, by which time they would have been mighty hungry.

The same result occurs in the absence of high-speed intergalactic travel, every day, as we pass each other on the street. But the difference in our relative speeds is imperceptibly small, and we cannot discern the time discrepancy. But just as a tiny shift in a rocket's path will cause it to miss a distant target by a wide margin, the unnoticeable discrepancies in our everyday notions of time would become significant if our separation in space were substantial. If, instead of being with us in this room, one of you were ten light years away, moving at 9.5 light years per hour, an event that would appear to you to have occurred at any moment here in this room would appear to us to have occurred four seconds earlier or later, depending on whether you were moving toward us or away from us. At 10 billion light years away, the discrepancy would be about 141 years.

Under the laws of relativity, what constitutes a moment in time, and our concepts of past, present and future, are completely subjective. Relativity is not in our bones, and its implications are foreign to our intuition. We all experience the same gravitational field, but we travel extremely slowly compared to the speed of light. Our space shuttles don't come close to one ten-thousandth the speed of light, and we judge reality by people and objects that, by cosmic standards, are very close to us, so we cannot sense these subtle discrepancies.

But even Einstein was not the last word on time. Einsteinian relativity is a valid framework for understanding the universe on the largest of scales – stars, galaxies, clusters of galaxies, and beyond, to the end of the universe, now some quadrillion miles away. At the other end of the spectrum, quantum mechanics studies the universe on its smallest scales, in the micro-world of molecules, atoms, neutrons, electrons and even microscopically invisible, and perhaps only theoretical smaller matter. Those studies challenge and disrupt the symmetry of $E=mc^2$ relativity.

Quantum mechanics is a world of chaos, ruled by Heisenberg's principle of uncertainty, in which all possibilities, including mutually contradictory ones, coexist and have a reality of their own. It is the world of Schrodinger's cat, the theoretical cat that, at any instant might be both alive and dead, or possibly half-alive and half-dead, and every combination in between. It is the world of the salt and pepper bowl, which, if shaken enough times, there will eventually be at least one shake when all the grains of salt fall together on one side of the bowl, completely separated from all the grains of pepper on the other side; and in which shards of a broken glass will re-form into the perfectly unbroken glass and a broken egg will un-break.

In quantum mechanics, high-speed fluctuations of sub-atomic particles in time periods as brief as a Planck era so mangle time and space that the laws of relativity, along with all of our conventional ideas of left and right, backward and forward, up and down and before and after, become meaningless. Whereas relativity established the subjectivity of time's passage, quantum mechanics challenges the concept of time itself.

Einstein was horrified by the chaotic nature of quantum mechanics. "God does not play dice with the universe," he said, and spent the last 30 years of his life in a quixotic search for a unified theory of everything, under which all laws of nature are governed by one elegant, but simple underlying principle.

The idea of a universe governed by one set of laws when things are large and another incompatible set of laws when things are small is untidy and unacceptable to most scientists, and they continue to search for an ever-deepening understanding of the basic nature of the universe, but an all-encompassing unified theory, with the answers to everything, may never be found. Others predict that time will eventually prove to be only a secondary derivative characteristic of our universe that emerges from more basic, but as yet unidentified, elements, and then only under certain conditions – conditions such as the "Big Bang". Some theorize that quantum mechanics, extended to its extremes, may find that our universe is only part of a much greater "megaverse", born in a seething foam of tangled space-time, with quantum fluctuations from which countless other universes may pop into and out of existence, and in which, time, as we experience it, may or may not exist.

Superstring theory, quantum loop gravity and "M theory" are some of the current theories seeking that Holy Grail. Superstring theory predicts that the most basic form of matter consists of irregularly shaped, vibrating strands of energy, which, for lack of a better name, are called "strings". It postulates that space has possibly as many as 11, and, in some hypotheses, up to 26 dimensions, and predicts the existence of many new elementary particles and forces within those dimensions. There is as yet no observable evidence of any of this.

Quantum loop gravity explores the possibility that time comes in discrete, separate pieces called "ticks", which are separated by Planck eras of 10 to the minus 43rd power fractions of a second, but there is nothing in the space between the "ticks".

"M theory" is an extension of superstring theory which postulates the existence of surfaces called "branes" – B-R-A-N-E-S – short for membranes.

This is an excerpt from a New York Times science section article explaining "M theory" as simply as possible to its general readership:

"The ekpyrotic process begins far in the indefinite past with a pair of flat empty branes sitting parallel to each other in a warped five-dimensional space….The two branes, which form the walls of the fifth dimension, could have popped out of nothing as a quantum fluctuation in the even more distant past, and then drifted apart."

This is the stop on the information highway where my brain, spelled B-R-A-I-N, gets off.

It's about time.

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