Chapter 3

Time

In the summer of 1969, the rock group Chicago released a single that asked, "Does anybody really know what time it is? Does anybody really care?" The record shot to number one on the charts, having struck a chord with the rebellious youth of that era. The hippies of the sixties counterculture professed that they wanted to do away with all the trappings of social conformity. And what is time but just another social convention?

If the hippies had gotten their way and established a clockless, calendarless society, how would they have coordinated their activities with other people? How would they know when to catch the train in the morning? How would they know when to drop off their kids at soccer practice? How would they know when the rent was due?

As I write this, I am on a flight scheduled to arrive in Philadelphia at 6:15 PM on Friday, March 28. When the plane lands, my daughter will be at the airport to pick me up, as will the friends and family members of my fellow passengers. We know this because we all agree about what 6:15 PM on March 28 *means*. We know what time it is, and we care.

All the Rest Have Thirty-One

The oldest artifact believed to have functioned as a calendar is the Lebombo bone, a 35,000-year-old baboon leg bone with 29 tally marks carved in it. It was evidently used for counting 29 of something. Twenty-nine what? Probably the days of the lunar cycle. Most early calendars were based on the moon, rather than the sun, because lunar cycles are shorter, and you can see where you are within a cycle by looking at the shape of the moon.

The Islamic calendar is lunar, which is why the symbol for Islam is a crescent moon. The months of the Islamic calendar alternate between 29 and 30 days, keeping the calendar in synch with the 29.5-day lunar cycle. Every month begins with a new moon.

The problem with a strictly lunar calendar is that it quickly drifts out of synch with the seasons. A calendar of 12 lunar months includes only 354 days, and therefore drifts by 11.25 days every solar year. If you were born in mid-summer, your 16th birthday would be in mid-winter.

To address this problem, some cultures added a 13th month, known as an intercalary month, every two or three years. The Hebrew calendar adds an extra month in seven of every 19 years, so that over a 19-year period, the average length of the calendar year is very close to the length of a the solar year. That's why the Jewish New Year, Rosh Hashanah, jumps around from year to year on the modern calendar, but always stays within a couple weeks of the autumnal equinox.

"The Red Cow and First Chinese Horse," Lascaux, France, 15,000 BCE. This cave painting is believed to be a lunar calendar. There are 29 black dots curving along the front of the horse. The small inward loop of five dots presumably represents the five nights when the new moon disappears from the sky.

A Roman calendar on a wall painting from 60 BCE. The first 12 columns correspond to our modern 12 months. The 13th, labeled "INTER," is an intercalary month. The "k" that appears before each month's abbreviation (as in "k-JAN" in the upper-left) stands for *kalends*, the word for the first day of the month, from which the calendar gets its name. The kalends was originally the day of the new moon. New Year's Day was the Kalends of January because that was the day when newly elected civil officials took office. At the bottom of each column is the number of days in each month, usually either 31 (XXXI) or 29 (IXXX).

Here in the modern West, we don't care that much about the moon. We expect our Fourth of Julys to be hot and our Christmases to be white, but most people couldn't tell you the date of the next new moon. We can trace our "who cares?" attitude about lunar cycles back to the ancient culture who gave us our calendar—the inventors of the 31-day month—the Romans.

The Romans believed that even numbers were unlucky, so most of the months in their calendar had either 31 or 29 days. The intercalary month had 27. February had 28.

Poor February. The Romans took a dim view of that month, coming as it does in the dead of winter. February was the time for the ritual purification of sins, analogous to the Christian season of Lent. February was no fun, and the Romans saw no reason to give the dreary month any more days than necessary. When February was first added to the calendar, it had only 23 days. The Romans later gave it five more, but that was as far as they were willing to go.

The Roman calendar originally had only ten months, as winter was considered a monthless season. When January and February were inserted into the beginning of the year 450 BCE, they bumped all the other months back by two positions. That's why the ninth, tenth, eleventh, and twelfth months of the year—September, October, November, and December—are named after the seven, eight, nine, and ten.

February was named after the Latin verb for "purify," April for the verb for "open." The other months at the beginning of the year were named after Roman gods: Janus, the god of beginnings and transitions; Mars, the god of war; Maia, the goddess of spring; and Juno, the goddess of marriage. July and August were renamed in honor of Julius Caesar and Augustus Caesar.

When Julius Caesar took power, the calendar was a mess. The Romans had no automatic system for determining which years would include an intercalary month. That was left to the discretion of the Pontifex, the highest ranking priest of Rome. As Roman politics became contentious, the Pontifex began to wield his power for political ends, lengthening the year to 13 months when his friends were in office, and keeping it to the minimum of 12 months when they weren't. Because the intercalary month was no longer being used to keep the calendar in sync with the solar year, seasonal drift became severe.

As dictator of nearly the entire Western world, Julius Caesar was in a unique position to do something about the calendar. After consulting the leading astronomer of his time, Caesar decreed that the calendar year would have a consistent length of 365 days, with an extra day added every four years. Intercalary months were abolished. Days would be divided equally among the 12 months, giving each month either 30 or 31 days, except for the black sheep, February. The Julian calendar was adopted throughout the empire in the year now known as 45 BCE. It remains the basis of the calendar we use today—with one small tweak.

By the 16th century, astronomers realized that the solar year isn't exactly 365.25 days. It's actually 11 minutes shorter, more like 365.2425 days. This error accounted for a seasonal drift of three days every four centuries. As a result, Easter, which is based on the vernal equinox, was slowly creeping toward the beginning of the calendar year. The vernal equinox had drifted 11 days since 325 CE, when the Council of Nicea had declared that the equinox would forever be on March 21. Pope Gregory XIII decreed that henceforth there would be a leap day in only 97 of every 400 years. There would not be a leap day on years divisible by 100, unless the year is also

January's namesake, the two-faced Janus could look backward and foreward at the same time. Depicted here on a coin from 220 CE.

Julius Caesar on a Roman coin from 44 BCE, the year he was assassinated.

divisible by 400. Thus, there was no leap day in 1700, 1800, or 1900, but there was one in 2000.

For centuries after Roman Catholic countries had adopted the Gregorian reform, the Protestant and Eastern Orthodox countries continued to use the Julian calendar. For the sake of convenience in international trade, all countries eventually adopted the Gregorian calendar—with the last holdout, Greece, doing so in 1923.

Gregory also had the calendar skip over ten days so that the vernal equinox would once again fall on March 21. Which leads me to one of my favorite trivia questions:

Q. What happened on October 5–14, 1582?
A. Nothing.

Those dates never existed, at least not on the Gregorian calendar.

AD

George Carlin posed the question, "What year did Jesus think it was?" In ancient times, the common practice was to count the years from the beginning of the reign of some monarch, usually the current king. Our *anno domino* (year of the Lord) system was devised by a 6th-century monk named Dionysius Exiguus. Dionysius was constructing a table that listed the dates for Easter, and he needed to number the years. The practice at that time was to number years from the beginning of the reign of the Roman Emperor Diocletian, who happened to be a notorious persecutor of Christians. Rather than honoring the memory of that tyrant, Dionysius stated that the present year was 525 years "since the incarnation of our Lord Jesus Christ." Dionysius presumably based year one on the account in the Gospel of Luke, which places Jesus' birth "In the time of Herod king of Judea." Herod died in 4 BC, so most New Testament scholars now place the actual year of Jesus' birth several years earlier. There is no year zero because the mathematical concept of zero did not exist in Dionysius' time. The secular abbreviations CE (for "common era") and BCE ("before common era") were originated by Jewish academics of the 19th century.

Thank God It's Frigg's Day

The life of society runs on seven-day cycles. It would be unthinkably awkward to schedule a recurring event that happens every six days or every eight days. Staff meetings, college classes, TV shows, piano lessons, therapist appointments, and football games recur weekly.

We can trace the seven-day cycle back to the ancient Hebrews. According to their familiar myth, after creating the universe in six days, God gave Himself a well deserved day off. Later God commanded that the faithful do likewise:

> "Six days you shall labor, and do all your work, but the seventh day is a Sabbath to the Lord your God. On it you shall not do any work."

Those Jews, Christians, and Muslims who obeyed the commandment would, for one day in seven, turn their minds and hearts away from the daily grind of survival to focus on higher concerns.

In the fourth century, the Roman emperor Constantine converted to Christianity, and soon after, the Romans replaced their eight-day market cycle with the seven-day week. The Romans named the days of the week after the sun, the moon, and the five known planets, which were named after Roman gods. When the week was introduced to the Germanic people of northern Europe, they renamed most of the days after their own Norse gods: Woden, the king of the gods; Frigg, his wife; Thor, the god of thunder; and Tiw, the Mars-like god of war.

The order of the days is based on a rather complicated system. The Romans believed that the planets orbited the earth in the following order, from closest to farthest: Saturn, Jupiter, Mars, the sun, Venus, Mercury, and the moon. According to astrology, each hour was governed by one of those planets. The first hour of the first day was governed by the closest planet, making it Saturn's day. The second hour was governed by the second-closest planet, and so on, with the cycle repeating every seven hours. The first hour of the second day (the 25th hour of the week) was governed by the sun, making that day the sun's day. That's why the sun's day immediately follows Saturn's day.

A
B
C
D
E
F
G
H
A

The Romans followed an eight-day cycle known as the *nudinal* cycle (after the word for "nine" because on the ninth day it started over again). On the Roman calendar, the cycle was denoted by the repetition of the letters A through H. Every eighth day was a market day, literally a "red letter day."

The Norse gods, Frigg, Woden, and Thor are seated at the center of this 1817 painting, “Balder’s Death,” by Christoffer Wilhelm Eckersberg. Balder, the son of Woden and Frigg, was murdered by the treacherous Loki, who smiles at the far left of the painting.

The order of the days was thus:

1. Saturn’s day
2. Sun’s day
3. Moon’s day
4. Mars’ day (a.k.a. Tiw’s day)
5. Mercury’s day (a.k.a. Woden’s day)
6. Jupiter’s day (a.k.a. Thor’s day)
7. Venus’s day (a.k.a. Frigg’s day).

As Christian tradition established Sunday as the first day of the week, Saturday was shuffled to the end.

The two-day weekend is recent idea. In the late 19th century, the American labor movement began calling on the government to mandate shorter working hours and a second day of leisure. American Jews argued that the second day should be Saturday, so that both Jews and Gentiles could observe the Sabbath on a non-work day. Henry Ford hated labor unions and was not fond of Jews, but he liked their idea of a two-day weekend because it would give people more leisure time for driving cars. In 1926, Ford began to shut down his factories on both Saturday and Sunday. In 1938, President Franklin Roosevelt signed the Fair Labor Standards Act that established a five-day, 40-hour work week for many workers. Since then, the pulse of American life beats to a five-on, two-off rhythm.

Better Days

The Gregorian calendar is so riddled with inconsistencies that it requires the memorization of a mnemonic—one that begins as a bouncy rhyme (“Thirty days hath September…”) but quickly deteriorates into fine print. People have proposed various reforms, including calendars that begin on the spring equinox, calendars that divide the days more equitably, and calendars with whole numbers of weeks—good ideas that have died slow deaths under the weight of cultural inertia.

The most serious attempt was the World Calendar, proposed by the United Nations shortly after World War II. In the World Calendar, every month has either 30 or 31 days. There are 52 whole weeks, so January 1 falls on a Sunday every year. To make that possible, one day (called “World’s Day”) falls outside of the weekly cycle. So does Leap Day. Those who opposed the World Calendar did so on religious grounds. Because of World’s Day, there are eight days between Sunday, December 24 and Sunday, January 1, which violates God’s commandment to observe the Sabbath every seven days. Largely because of this objection, the United States vetoed the proposal.

One idea that did achieve official adoption—albeit briefly—was the French Republic Calendar. Created by a commission in the wake of the French Revolution, the calendar sought to throw off the shackles of the past. The calendar had five days (six in a leap year) known as the “complementary days,” which fell at the end of the year and didn’t belong to any month. The remaining 360 days were divided into 12 months of 30 days each. Each month was divided into three 10-day *décades*, which were analogous to weeks.

The French Republic Calendar was the official calendar of France from 1793 until its abolishment in 1805. Ironically, it was the workers, the supposed beneficiaries of the revolution, who most strongly opposed the new calendar. The workers were accustomed to having off one day in every seven. When that changed to one in 10, they weren’t happy. Their complaints led to the calendar’s demise.

The nine-day work week was clearly a bad idea, but the rest of the calendar made a lot of sense. It’s too bad the French threw out the baby with the bathwater. If they had simply

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The World Calendar

The French Republic Calendar from the year we know as 1794. Notice that the 12 columns are of equal length. The five extra days at the end of the year are listed horizontally along the bottom. The months were named after nature: Grape Harvest, Fog, Frost, Snowy, Rainy, Windy, Germination, Flower, Pasture, Harvest, Summer Heat, and Fruit.

shortened the week, while keeping the overall structure of the calendar, then perhaps their logical new calendar would have spread over the world the same way their metric system did.

I realize the time is not ripe for calendar reform, but allow me to put a proposal on the table. Think of it as the French Republic Calendar, version 2.0. Like the original, it consists of 12 30-day months and a five (or six) day holiday at the end of the year. (I have named this holiday “Festivus.” Those who do not observe Festivus may celebrate the winter holiday of their choice.) Unlike the original, each 30-day month is divided into five weeks of six days each. There are no more Tuesdays. A six-day week would give rise to such useful subdivisions as the half-week and third-week. I’m quite certain that given the chance, the new calendar would appeal to saints and sinners alike. The former, their hearts swelled by the magic of Festivus, would admire the elegant mathematical regularity of the design. The latter would appreciate the four-day work week.

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February

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August

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September

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October

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November

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December

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Festivus

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A modest proposal

The Hands of Time

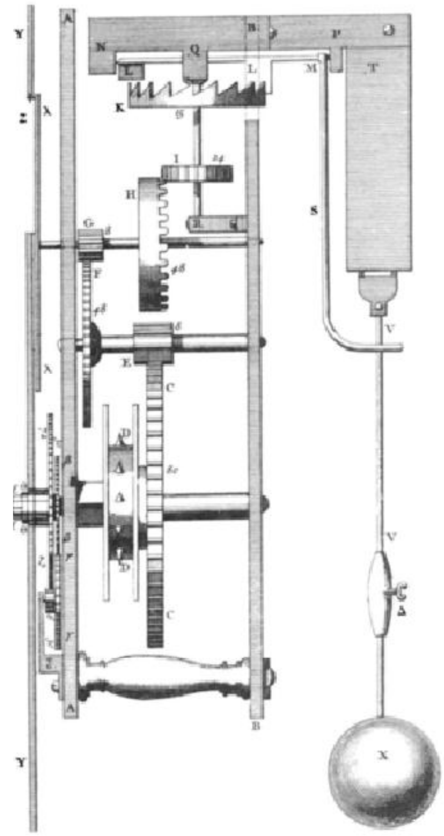
Galileo is best know for dropping balls from the leaning tower of Pisa, something he almost certainly never did. It's not that Galileo wouldn't have been interested in such as experiment, but there were no timekeeping devices accurate enough to measure the speed of anything so rapid as a free-falling object. What Galileo did instead was roll balls slowly down a ramp, measuring the elapsed time with a water clock, an hourglass-like device through which water trickled at a constant rate.

According to another story—one that might actually be true—one day in the cathedral at the University of Pisa, Galileo became intrigued by a swinging chandelier and began to measure the duration of each swing by counting his pulse. *One, two. One, two.* It didn't matter how high or low the pendulum swung. *One, two.* The time it took to swing back and forth was always the same. *One, two.* Galileo had discovered the essential property of pendulums. He soon came up with the idea of using a pendulum to regulate the motion of a clock, but he died before he could complete the project.

The Dutch mathematician, Christiaan Huygens is credited with inventing the pendulum clock in 1654. Huygens' first clock had no face or hands. It would merely chime on the hour. (The word "clock" is from the Celtic word *clocca*, meaning "bell.". The word "hour" is from the Old French *hore*, meaning one-twelfth of a day.)

The practice of dividing the daylight into twelfths was established in the Mediterranean world long ago. In the tomb of the Egyptian Pharaoh Amenhotep I, who reigned around 1,500 BCE, there was a sundial marked off in twelve segments. In the same tomb was a water clock that divided the nighttime into twelfths.

When clock faces were first designed, they were modeled after sundials. The clockwise movement of the hour hand is similar to the path of the shadow on a northward-pointing sundial. If sundials pointed south instead of north, the direction we call "clockwise" would undoubtedly go the other way. The 12-hour clock face is modeled after a sundial as it appears during the daylight half of the day. That's why the hour hand has to goes around twice a day—once in daylight



Christiaan Huygens' first pendulum clock was accurate to within 15 seconds a week, much more precise than any water clock. In pendulum clocks, the pendulum works in concert with an escapement mechanism (K and L at the top of the illustration), which allows the clock's wheels to turn a fixed amount with each swing of the pendulum. The "tick" of a clock is sound of the escapement releasing one of the teeth on a wheel, allowing the wheel to turn slightly. The "tock" is the sound of the opposite arm of the escapement stopping the motion of the wheel.

and once in darkness.

Minute hands and second hands did not commonly appear on clocks until the late 17th century, after clockmakers had invented better escapement mechanisms that made clocks more accurate. The “minute” hand was so named because it indicated small, *minute* increments of time. The “second minute” hand ticked off smaller *secondary* increments.

Large clock towers were erected in cities and towns throughout Europe. Each town set its clock according to the sun; if the clock struck noon when the sun was at its peak, then the clock was set correctly. The time in your town was slightly different from towns to the east or west. With the advent of high-speed, long-range railroad travel in the 19th century, it became important for all towns to agree on timekeeping standards. So in 1847, the first time zone was established. By agreement of British railroad companies, all clocks on the island of Great Britain would be set to the same time, known as “railroad time.” Railroad time was synchronized with the sun as it appeared over the Royal Observatory in Greenwich, London. By 1929, most major countries had established time zones offset from the time in Greenwich.

The railroads also led to the widespread use of pocket watches, as people tracked the comings and goings of trains. The pocket watch used a balance wheel, a weighted wheel that wobbled back and forth somewhat like a pendulum. The wheel was driven by a tightened, coiled spring. Pocket watches were invented soon after the pendulum clock, but were less accurate and reliable than pendulum clocks. In 1891, a passenger train crashed into a freight train in Kipton, Ohio, killing eight people, because one of the engineers’ watch had stopped for four minutes. After that incident, the railroads established standards for watches—among them, that a watch must be accurate to within 30 seconds a week.

The accuracy of timekeeping increased dramatically in the 1920s with the invention of the quartz clock. In a quartz clock, an electric current is passed across a quartz crystal, causing the crystal to vibrate like a small tuning fork. Quartz crystals can be laser-trimmed to vibrate at a specific high frequency, usually 2^{15} (32,768) cycles per second. This enables quartz clocks to accurately measure split-second periods of time.

Starting at the 1932 Olympics, official timed results were measured with quartz clocks to the nearest tenth of a second.

A sundial in the early morning.

By 1952, they were measured to the nearest hundredth of a second, and by 1992, to the nearest thousandth of a second (or millisecond). At the winter Olympics of 1998, the gold medal in the women's luge competition was won by two milliseconds. To give you and idea of how close that is, one up-and-down flap of a housefly's wings takes three milliseconds.

With the advent of satellites and electronics, even more precision was needed. It was no longer adequate to define a second as a fraction of the time it takes the earth to rotate because that time period is somewhat irregular, influenced each day by the position of the moon and other factors. Not only that, the earth's spin is slowing down by about 1.8 milliseconds a century. A million years from now, a day will be about 18 seconds shorter than it is now.

A more regular cycle in nature is the oscillation of an atom. The energy state of an atom changes at a rapid and absolutely regular frequency. Starting in 1949, devices were built to detect th0se oscillations and use them—like a tiny pendulum—to regulate a clock. Atomic clocks are now used for international timekeeping standards, and a second is now technically defined as the time it takes for a cesium 133 atom to oscillate about nine billion times (9,192,631,770 times, to be precise). Some atomic clocks are accurate to within one second in every 30 million years.

If Galileo were to drop balls from the leaning tower of Pisa today, he could measure their elapsed time in nanoseconds (billionths of a second). If that's not good enough, the most precise time measurements are now accurate to the attosecond, which is one billion-billionth of a second.

DST

It was George Vernon Hudson, not Benjamin Franklin, who first proposed the idea of daylight savings time. In 1895, the clock-punching New Zealander complained that after working the day shift, he didn't have enough daylight hours to pursue his hobby of insect collecting. Hudson presented a paper to the Wellington Philosophical Society proposing that clocks be advanced in the summertime so that afternoons have more daylight. The idea caught on and is in effect in most areas of the United States, Canada, and Western Europe.

A Stubbornly Persistent Illusion

So what exactly is it that we're keeping track of? What *is* time? Everyone has a strong intuitive sense of time, but the fundamental nature of time is hard to define. As Saint Augustine put it, "What then is time? If no one asks me, I know what it is. If I wish to explain it to him who asks, I do not know."

Isaac Newton held a common sense view. Newton believed that time is part of the framework of the universe created by God. In Newton's universe, space is an infinitely large three-dimensional container, and time is the fourth dimension in which events occur in sequence. Time passes uniformly, uninfluenced by anything inside the container, marching with clock-like regularity toward the infinite future.

Newton's conception worked perfectly well until people started to measure the speed of light. When they did, they found that every beam of light was measured at the same speed. It didn't matter if the light was creeping up from behind the earth (traveling in the same direction as the earth's movement) or crashing into the earth head-on. How could that be?

That was the question pondered by a young clerk from the Swiss patent office named Albert Einstein. One day while riding a trolley past the clock tower in Bern, Einstein began to imagine what it would be like if the trolley suddenly accelerated to the speed of light. If Einstein's trolley passed the clock at one second before noon, he would essentially be surfing on a wave of light that showed the clock at 11:59:59. As he looked back at the clock, time would had slowed to a stop.

Einstein's theory of relativity says—among other things—that time slows down when you're traveling very fast. Imagine there are two infant twin brothers. One of them travels in a spaceship at near the speed of light, while the other stays home. When the spaceship returns, the traveler is still a baby, though his earthbound brother has become an old man. Scientists have shown that time dilation actually happens. In 1971 two scientists took an atomic clock aboard a high speed commercial airliner and flew westward all the way around the world. When they landed, they found that the clock on the ground was 273 nanoseconds (.000000273 seconds) faster than the clock on the plane. They had traveled 273 nanoseconds into the future! That might not seem like much, but it's enough to show that time is not absolute. Time is one of the dimensions of stretchy, squishy, interwoven space-time.

Nothing in relativity gives any special status to the present moment. According to the theory, there is no universally experienced moment of *now*. There are instead many different *nows*, each one relative to a specific observer. When you look at the night sky, you see the moon not as it is "now," but as it was 1.5 seconds ago, when the light you are seeing left the moon's surface. When you look at the Andromeda galaxy, you see it as it was 2.6 million years ago. Even when you gaze into the eyes of your beloved, you see her not as she is "now," but as she was when the light you're seeing was reflected off her sparkling eyes. Another observer—on the moon, or in Andromeda, or even sitting across the table from you—would observe a somewhat different tapestry of *nows*. The present moment seems special to you only because that's where you, as an observer, happen to be located in space-time.

What's more, *all* moments are equally real. All moments, not just "the present," exist as locations in space-time. The moment you are born exists. The moment you meet your best friend exists. The moment you get out of bed tomorrow exists. The moment you die exists. It just so happens that you aren't visiting any of those locations in space-time right "now."

Late in his life, Einstein seemed to genuinely believe in a tenseless universe. When his lifelong friend, Michele Besso died, he wrote a letter consoling Besso's family:

> "Now he has departed from this strange world a little ahead of me. That means nothing. People like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion."

What then is the nature of this illusion we call time? The 17th-century philosopher, Immanuel Kant gave a pretty good answer when he said, "Space and time are the framework within which the mind is constrained to construct its experience of reality." Kant believed that the mind is not a blank slate—that it has knowledge of certain basic concepts prior to any experience, and among these innate concepts are space and time.

We perceive ourselves as being "in" the present, moving "toward" the future. The past is inaccessible, except through memory. Physicists tell us that this apparent directionality of time—the so-called arrow of time—is a consequence of the second law of thermodynamics, which states that all systems always progress toward disorder. We live in a universe where sandcastles crumble into sand, but sand does not spontaneously assemble into castles. (Sure, you can build a sandcastle, but the heat you burn in the process will contribute to the overall disorder in the universe.) From any given location in space-time, you are on a one-way street toward disorder, but you perceive it as a one-way street toward the future.

The wild-haired Einstein is revered as an icon for genius, but his ideas haven't found their way into the everyday conceptual models that people use to make sense of the world. For example, science tells us that the big bang occurred about 14 billion years ago. To most of us, it seems perfectly reasonable to ask, "So what happened 15 billion years ago?" or even more precisely, "What happened at noon on Thursday, January 1 in the year 15 billion BC?" (And yes, that date would have been a Thursday.) To these questions, physicists can only shake their heads and explain that time prior to the the big bang does not exist. There was no *then* then.

Modern cognitive science largely affirms Kant's view of time as an innate concept. Though there is no central clock or timekeeper in our heads, at least none that neuroscientists have been able to identify, it seems that systems for time perception are widely distributed throughout the brain. Time perception gives people an ability to make sense of the world in terms of past, present, and future. Our concept of the past is useful for making sense of memory and using memory as the basis for learning. Our sense of the present lets us perceive events meaningfully as they happen. (Our subjective experience of the present is actually memory of the very recent past—the last three seconds or so. The psychologist William James dubbed this period of time "the specious present" and defined it as "the short duration of which we are immediately and incessantly sensible.") Our concept of the future, which is modeled after memory of the past, is essential to planning. These concepts of past, present, and future are shaped as they are because those shapes afforded the greatest survival advantages to our distant ancestors.

If time is an illusion, it is an indispensable illusion. It is a beautiful illusion. To that illusion do we dance.

Notes

All the Rest Have Thirty-One

The photograph of "The Red Cow and the First Chinese Horse" is from the Lascaux website, Ministère de la Culture et de la Communication.

The photograph of the Roman calendar, *Fasti Antiates Maiores*, is from the National Museum, Palazzo Massimo, Rome.

The Janus coin is from the Bibliothèque Nationale, Paris.

The Julius Caesar coin is from Whirlwinds.com.

Thank God It's Frigg's Day

"Balder's Death" is from Museum fur Kunst, Copenhagen.

Better Days

The French Republican Calendar, illustrated by Philibert Louis Debucourt in 1794, is from the Bibliothèque nationale de France.

The Hands of Time

The illustration of Christiaan Hygens pendulum clock is from *Geschichte der physikalischen Experimentierkunst*, by Ernst Gerland and Friedrich Traumüller, 1811.

A Stubbornly Persistent Illusion

St. Augustine's quote is from *The Confessions of St. Augustine, Book XI*.

Einstein's quote is from a letter to the sister of Michele Besso, written in March 1955.

Immanuel Kant's quote is from *A Critique of Pure Reason*.

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