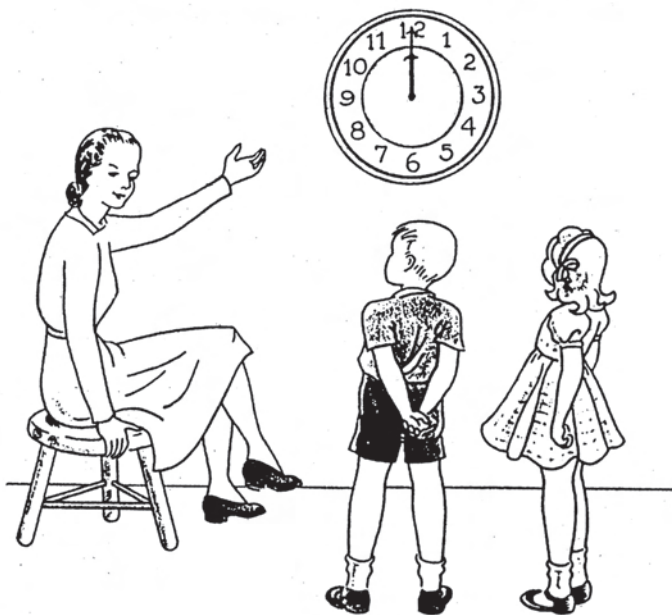


WE LEARN TO TELL TIME





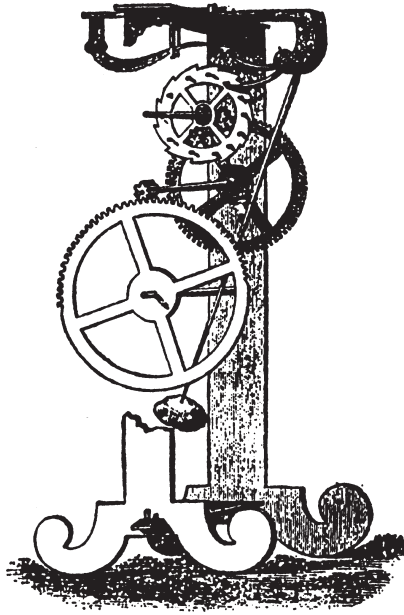
A BRIEF HISTORY OF TIMEKEEPING

MY ALPHABET VOLUME 20

CONTAINING

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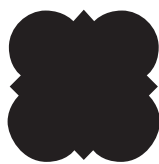
With illustrations on pages 1, 2, 6, 10, 16 and 18



I.

TIMEKEEPING IN ANCIENT EGYPT
CLASSICAL TIMEKEEPING
EARLY CHRISTIAN TIMEKEEPING
THE MECHANICAL CLOCK





TIMEKEEPING IN ANCIENT EGYPT

The first known example of a timekeeping device - the gnomon (Greek, meaning "to know") - dates from approximately 2000 B.C.; it was, quite simply, a stick in the ground. Before this groundbreaking innovation, an approximate time could be indicated by pointing to a place in the sky where the sun would be at a given time of day; with the invention of the gnomon, it could be indicated by the length of the shadow cast by the stick.

This simple technology was quickly improved upon - by circa 1500 B.C., the Egyptians were using not only a T-shaped proto-sundial (calibrated to divide the day into twelve equal parts), but also a more sophisticated timekeeping device which didn't rely on sunlight: an outflow water clock. This clock consisted of a basin with a small hole in the bottom out of which water would slowly flow. The interior surfaces (which were often, in more developed versions of the clock, slanted to compensate for decreasing water pressure²) were marked with scales dividing the day or night into twelve equal parts.

Two hundred years later (circa 1300 B.C.), timekeeping technology was once again improved upon by the Egyptians. This was the first appearance of the sundial proper, i.e., a disk with a pointer which, instead of measuring time by the length of a shadow, measured by the direction of the shadow.

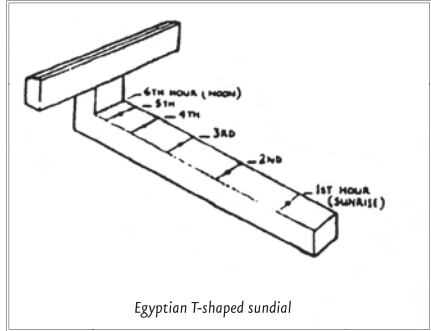
CLASSICAL TIMEKEEPING

The Greek historian Herodotus (ca. 484-425 B.C.) tells us that the Greeks adopted the use the sundial and the twelve-hour day from the Babylonians. Prior to this, the Greeks had divided the day into three or four segments named for mealtimes and/or other activities; the Greek word "hora" (the origin of the English "hour"), which was, at the time of Herodotus' writings, used to indicate the twelve hour segments of the day, had previously been used to describe periods of greatly varying lengths from an afternoon to a whole season.

Regardless, the sundial and the water clock are known to have been in use in Greece circa 550 B.C. The Greeks improved both forms of technology, notably in the calibration of sundials to the latitudes of particular cities. By 330 B.C., a

portable universal sundial had been invented. The most distant precursor to the portable clock was able to be "set" to the latitude of any location; presumably it was intended for use by traveling businessmen or political officials.

The water clock, which had been given the new name clepsydra (Greek, "water thief"), was modified from the outflow system used by the



Egyptian T-shaped sundial

Egyptians to an inflow system. The clepsydra consisted of two basins, with water flowing from one basin into another. The first basin was continuously filled to keep water pressure constant; the second basin was marked with gradations indicating hours. The clepsydra was used mostly to time legal proceedings - litigants were allotted a certain number of jugs to make their case. The clepsydra also found use as an alarm clock: when the water in the second basin rose to a certain level, it would tip over a container filled with metal balls or pebbles which would then spill onto a metal plate at the base of the clock³.



According to the Pliny the Elder, the sundial was first brought to Rome in 264 B.C. as plunder from Sicily during the First Punic War. As it was calibrated for a different latitude, its users were provided with the incorrect time for one hundred years, at which point the Censor Q. Marcius Philipus presented Rome with its first sundial set to local time. Apparently this generated some public interest in timekeeping; five years later (159 B.C.), a large public water clock was erected. Again according to Pliny, this was the first instance of

time being marked for the Roman public.

One year after the construction of the water clock, the monumental Tower of the Winds was constructed. The enormous public clock consisted of a clepsydra and eight sundials, each one facing in the direction of one of the eight winds identified by Homer.

In 10 B.C., Augustus Caesar commissioned the construction of an enormous public sundial in the Campus Marius. A giant obelisk served as a pointer, while inlaid bronze lines on the surrounding pavement marked the hours. This monument to the importance of timekeeping was most likely appreciated by the Roman public - wealthier Romans of the time could be seen sporting sundial "wristwatches" a little over an inch in diameter, and nine years later (1 B.C.), Vitruvius would record thirteen different types of sundials in use in Rome.

EARLY CHRISTIAN TIMEKEEPING

The three major monotheistic religions of the western world - Judaism, Islam and Christianity - all placed a significant amount of emphasis on times of worship. However, whereas Islam and Judaism remain fairly vague on this topic - Judaic tradition calls for prayer in the morning, afternoon and evening, Islam for prayer at dawn, noon, before and after sunset and after the fall of darkness - Christianity was much more specific. For example, the early Church Father Tertullian (160-230) called for prayer at the third, sixth and ninth hours of the day⁴ in addition to the more approximate times of worship the Church had borrowed from Judaism.

Despite the efforts on the part of the Church to regiment times devoted to worship, they remained very approximate and varied from locale to locale. To further complicate matters for the Church Fathers, the hours of prayer were often shifted to accommodate more secular concerns, i.e., it was not frowned upon to delay the (already approximate) sixth hour prayer until some business had been taken care of, or to put off the morning prayer until after breakfast, etc.

A definite precedent was finally set by St. Benedict (480-543), whose Benedictine Rule sought to be a guide for "a communal life of humility and obedience to God." Predictably enough, the centerpiece

of the pious life envisioned by St. Benedict was daily worship, which was to occur seven times a day and once at night⁵. These times for prayer were called canonical hours, and they were announced in monasteries by the ringing of bells⁶. The times for ringing the bells were tracked via the use of crude sundials and water clocks.

THE MECHANICAL CLOCK

Although the exact date of the invention and the identity of the inventor remain unknown, credit for the development of the mechanical clock is usually given to Pope Sylvester; the date usually given is the year 996.

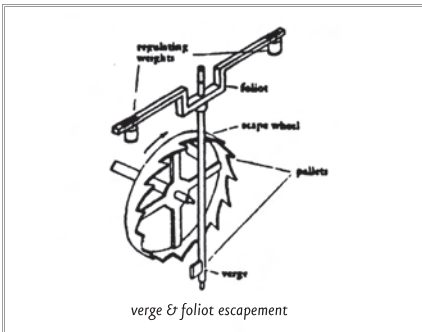
Exactly what this first mechanical clock was is also unknown. What is known is that the device (which did not strike, but was used in monasteries in the same manner as sundials and water clocks had previously been used: namely, to indicate times to ring bells to announce the call to prayer) was a weight-driven clockwork⁷. Most likely, it had four basic parts: (1) a weight which, as it fell, transmitted energy through (2) a gear train which was regulated by (3) an escapement and caused (4) the indicating mechanism (probably a dial) to turn. The form of escapement used in early mechanical clocks is yet another unknown; however, as you, the reader probably do not know what this device is, and as it is central in the development of the clock, it warrants an explanation. The escapement served to hold back the fall of the weight so the force of gravity would remain constant; it also oscillated at a regular interval. The movement of the dial essentially tracked the oscillation. In other words, without the escapement, it wouldn't be a clockwork - it would just be some gears with a weight attached to them.

The clock retained this basic form for some time; the first major innovation in its construction dates to 1286. It was in this year that the first striking clock was built at St. Paul's Cathedral. Like most early striking clocks, it had no dial; none was needed as it rang its own bells to announce the times for prayer.



The year 1309 provides the first detailed record of an escapement mechanism, from the Church of St.

Eustorgia in Milan. This particular form of escapement - the verge and foliot - was the most common throughout the fourteenth century⁸. It worked in basically the same manner described previously; however, as there are more detailed records of its operation, a more detailed explanation can be offered. To wit, the verge and foliot escapement served to impede the movement of a weight driven axle in such a way that a complete rotation of the axle would take a certain amount of



time, usually about an hour. This was accomplished by means of a saw-toothed wheel (the scape wheel) mounted on or linked to a gear train by an axle which would alternately block and release two pallets mounted on the verge perpendicular to each other. The foliot⁹ was a horizontal bar mounted on top of the verge, with weights attached to either end. The scape wheel pushed the verge and foliot in one direction until stopped by a pallet, then the direction of rotation would be reversed. The weights attached to the foliot regulated the duration of the oscillation.



The construction of clocks in the fourteenth century was a huge undertaking that lasted several years. The average clock weighed about two tons, not including the four-ton bells or the thousand pound weights for the verge. The labor use for construction came from a wide variety of trades; in addition to clock maker to oversee the operation, the construction of a clock would provide employment for blacksmiths, rope makers, carpenters, bricklayers, plasterers, gilders and bell founders.

Despite the difficulties involved and the sheer hugeness of such an undertaking, the vogue for clocks rapidly spread. What had once been the exclusive province of the Church had become a civic matter, and, ironically enough, the Church balked at the clock's growing popularity. They found particularly offensive the idea that a clock should strike not only the canonical hours, but all twenty-four hours of the day, as many of the more civic-minded financiers of clock construction had suggested. Eventually, the Church acquiesced to the idea of the twenty-four hour clock¹⁰, so much so that the first record of a clock striking all of the hours refers to a clock at St. Gothard's Church in Milan in 1336¹¹.

As more and more clocks were constructed, the striking of the hours became a problem. In 1370, so the story goes, Charles V of France was so upset by the constant striking of bells - some rang the beginning and end of the workday for various trades, some rang the canonical hours, still others rang every hour of the day but were always out of sync with each other - that he issued a royal edict stating that all the clocks in Paris had to chime in time with the clock at the Royal Palace. This set a precedent amongst disgruntled monarchs across Europe, and soon almost every kingdom had a similar law in effect.

Unfortunately for Charles V and everyone else, the problem with the bells wasn't legal, it was mechanical. Due to a combination of friction and irregular hand-cut gears, the foliot had no natural period of its own. As a result, the early weight-driven clocks lost anywhere from fifteen minutes to an hour per day. No matter how much legislation to that effect was enacted, they would never be able to stay in synch with each other. In addition, the manner in which they operated canceled out any hope of making a small clock, much less a portable one. For one thing, they had to remain stationary; and for another, they had to be tall enough to allow the weights room to fall before having to be reset.

An unknown Italian clock maker circa 1410 found a solution the problem of size which provided increased accuracy as well. This was the mainspring clockwork; its chief innovation was quite simply and as the name would imply, a

tightly wound spring. It functioned in essentially the same manner regardless of its size and did not depend on gravity. The force for driving the gear train was provided by the spring unwinding.

Of course, the mainspring had problems of its own. The spring provided an uneven force and resulted in the foliot oscillating too quickly when the spring was tightly wound and too slowly as it unwound. By 1480, an equally simple solution had been found: a cone shaped piece of metal (usually brass) called the fusee. The mainspring was attached to the fusee with a cord or chain and wound around it in such a manner that it would unwind from the wide end of the fusee when it was tightly wound (thus regulating the excessive force of the tightly wound spring) and from the narrow end as it became more slack (thus compensating for the decreasing force of the unwinding spring).

The trend towards miniaturization which had been the inspiration for the invention of the mainspring and the fusee was fueled by the new practicality and precision they made possible. The craze for little clocks spread rapidly, and the clocks kept getting smaller. The first known table clock belonged to Philip the Good and was listed in his 1430 inventory; a scant sixty years later the first wristwatches, invented by an unknown clock maker, appeared in Italy. The table clocks were fairly accurate by the day's standards, but the early watches were a bit ahead of the technology of the day. Not even the mainspring and fusee (which were the height of fifteenth century technology) could make accurate so tiny a timepiece, and the watches were comparable to the old weight-driven clocks in terms of inaccuracy. For the most part, they were status symbols akin to the little sundials sported by the wealthy Romans of antiquity.

Even with the advances in accuracy and miniaturization made possible by the mainspring and fusee and an increasing subdivision of time (a clock constructed at Wells' Cathedral in 1500 chimed every quarter-hour), clocks remained more or less inaccurate. The difficulty lay in the central mechanism of the clockwork, the escapement. The verge and foliot escapement combined two functions - the determination of segments of time (the foliot) and the counting of those segments (the verge) - into one mechanism. Both could be more

accurate if they were separated. This was known to be a problem to many clock makers, but none had a solution. One was eventually devised, in 1583, by Galileo.

The story goes that Galileo was sitting in church one day when the swinging lamps which accompanied the mass caught his attention. He timed them by his pulse and discovered that the interval of their oscillation remained more or less constant. This observation led him to the invention of the pendulum clockwork, in which the foliot's purpose was fulfilled by a swinging pendulum. Although Galileo had completely designed a pendulum clock, he never built it. His son Vincenzo was quite interested in the project and had been working on it but died (in 1641) before completing it. A pendulum clockwork based on Galileo's design was finally constructed in 1657 (seventy-four years after the initial design was completed by Galileo) by Christian Huygens and Salmon Coster, two young clock makers living in The Hague.

Shortly thereafter the pendulum clockwork was further streamlined by a more efficient replacement for the verge. Instead of rotating, the anchor or recoil escapement simply caught and released the scape wheel². Its smaller size allowed for smaller clocks to be constructed; in addition it interfered with the pendulum less than the verge had, making clocks more accurate.

The recoil/anchor escapement is variously attributed to either William Clement., who built the first recorded clock of this variety (in 1671 for King's College, Cambridge), or to Robert Hooke. Hooke had already made a name for himself in watch making as the inventor of the spiral-balance spring, a variation on the spring and fusee escapement. The increased accuracy provided by Hooke's invention made possible the manufacture of watches that actually worked. In fact, they were so accurate that they warranted the inclusion of not only a minute-hand but also a second-hand in their design. By 1700, both watches and clocks that counted the seconds were considered commonplace.



The anchor and pendulum escapement and the spiral-spring balance are a kind of culmination in timekeeping technology. Both were improved on; both were, eventually, surpassed by the quartz crystals, atomic clocks and digital technology which are all considered commonplace today. Aside from the increased synchronization and ridiculous amounts of accuracy made possible by these more recently developed technologies, not much has changed since 1700.

For most people, when the second-hand appeared, time had become as minutely subdivided as it could possibly be. The measurement of time was also ubiquitous - clocks were no longer heard chiming in the distance at the local monastery, there was one in almost every public building and many private buildings as well. They were so small that one could be strapped to your wrist or carried in your pocket. And they were accurate enough to be synchronized on a local level. Theoretically, they could be synchronized beyond that; it was only a matter of time.





II.

THE CIVIC LIFE OF THE CLOCK
TIME FOR SCHOOL
TIME FOR WORK
THE CLOCKWORK UNIVERSE
COMMUNICATIONS & TRANSPORTATION



THE CIVIC LIFE OF THE CLOCK

Before the fourteenth century, the clock affected the lives of most people only tangentially. Events such as the beginning and end of market, the opening and closing of the city gates, changing of the guard, curfew, etc., were timed by the ringing of the church bells which, of course, were rung according to the time kept by the church clock.

By 1300, most cities had adopted their own bells housed in communal town center towers to announce and regulate the various details of daily life. Although these same bells were also used to announce council meetings, public assemblies, court sessions, calls to arms, etc., their most basic function was as time signals.

While the timing and marking of daily events was already commonplace, the clock and its hourly (soon to be half-hourly, later quarter-hourly) ringing simultaneously indicated and caused a shift in the use of time. Whereas the town bells had signaled particular activities, the bells of the clock were strictly signals of time. Prior to the introduction of the clock into civic life, certain things were done when certain bells rang; after the clock entered the public domain, certain things were done at certain times³.

TIME FOR SCHOOL

Before the introduction of timing by the clock, the average school curriculum was arranged around a more or less standard canon of Latin works taught sequentially from least to most difficult. As western civilization developed, the body of knowledge to be studied increased, both through new developments and the recovery of historical texts, especially the Greek classics. This increased stock of knowledge and the resulting multiplication of texts to be studied produced no small amount of pressure on educators and students - there simply wasn't enough time to read or teach every 'important' work.

In his 1404 tract *De ingenius moribus*, the educator Petrus Paulus Vergerius suggests to his fellow educators the allotting of a certain amount of time to a theme or author to be studied⁴. While this probably would have happened with or without his advice - the times of school days and working

times for teachers were already regulated by time-keeping devices (church bells and water clocks) - it was in the early fifteenth century, after the clock made its way out of the monastery and into public life, that the school day began to be sub-divided. The hourly schedule common today, or at least a not too distant precursor, was firmly in place by the end of the fifteenth century; school regulations from this time period (most notably statutes from Ulm and Nuremberg) describe the dividing of the school day into hours in which different subjects were studied as an "old custom".

TIME FOR WORK

For most workers in the Middle Ages, work time was not strictly limited or determined. The amount of work done was set by economic demands and/or local customs and feudal authority. Work done outside the home or, more precisely work done outside of the lord or master's home, was on a 'job-order' basis, often with set times by which work was to be completed⁵ but no regulated times at which work was to be performed. When time spent working was measured at all, it was measured in years, weeks or days.

More specific time measurements in relation to work surface in two cases: those of guilds and day-laborers. Not surprisingly, this increased attention to detail led to problems. By the thirteenth century, there were two basic difficulties: among guild members (who were usually paid by the piece), there were concerns regarding guaranteed work times of equal lengths and thus a guaranteed wage; amongst day-laborers there was the more general concern of how much work could or had to be done. In the case of the guilds, the problem was resolved by codes and statutes setting minimum times for the production of one unit and/or the maximum number of units produced during a certain time. For day-laborers, the problem of time measurement was dealt with in a more obtuse manner; regulations were placed on the amount of money a day-laborer could earn in a week⁶.

Aside from these two relatively specific conflicts, there was a much more general concern which affected everyone who had to work: namely, when did the work day end? Alternately, the day ended when the church bells rang the evening

prayer or when the bells in the town square rang in the evening or when the sun started to set. The rather vague system engendered further conflicts as it could be so manipulated to the advantage of both employers and employees. By way of a solution, in the mid-thirteenth century European cities began to adopt, in addition to the arsenal of bells which regulated everything else, a work bell to announce the beginning and end of the work day.

The continuing conflicts revolving around regulating the length of the work day made an obvious and logical application for the mechanical clock which was just making its way into the urban environment. The first recorded use of a clock for the purpose of regulating the striking of a work bell dates to 1358 in the city of Valenciennes. Although the practice spread rapidly, the clock functioned mainly as a supplement to traditional methods of time measurement, i.e., the length of daylight.

For obvious reasons⁷ one of the first areas in which the clock was adopted as the exclusive method of measuring the work day was the growing mining industry of the fourteenth century. A statute dated 1372 and issued by the County Judge Johann von Usenberg of Bohemia-Moravia (where one of the most extensive mining operations of the day was taking place) fixes the work day for miners at eight hours: "four hours before noon, four hours after noon"; such precision would not have been possible without the use of a clock.

While the mines of Bohemia-Moravia provide the first example of the hour being used to determine the length of the working day, there is no indication that the miners were paid by the hour. This logical next step in the evolution of work time can be traced indirectly to the construction of the Milan Cathedral (and its attendant clock) in 1387. Although the records concerning the construction of the cathedral indicate that the workers' time was measured by the hour, there is no mention of how their rate of pay was determined. However, shortly thereafter (circa 1390) there appeared in and around Milan references to payment by the hour; it is safe to assume that this precedent was set on the cathedral construction site.

The idea of an hourly wage was slow to catch on, not becoming common in Europe until the late fifteenth century. Even then, for whatever reason,

it remained more or less confined to construction sites. The use of the clock to determine the length of the working day gained a much more rapid acceptance, probably because it seemed to provide a solution to the ongoing employer-employee

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conflicts over the length of the working day. To a certain extent, this proved to be the case. While in some ways the clock reduced workers' freedom (earlier measures such as the length of daylight were easier to manipulate), it also provided (for a while, at least) a guarantee against arbitrary lengthening of the workday by employers eager to squeeze extra labor out of their workforce.

It is often the case that a solution develops into a new set of problems over time and this was definitely true for the work clock. By the late seventeenth century, when clocks were simultaneously becoming smaller and more

common, control of time measurement in the workplace had become an issue once again. Various records from around Europe in this time period relate stories of local governments intervening on behalf of workers who complained of employers removing the clock from public view.

This was a problem not so easily dealt with, and the situation continued to escalate. Early factory reporting contains descriptions of hatred for the clock on the part of workers and employees who falsified the clocks in public view and prohibited workers from entering the workplace with wristwatches or pocket watches. The clock was put into the ambiguous position of being both a symbol of workplace tyranny and a tool towards insuring fair treatment of workers - a position that, in many cases, it still holds today.

THE CLOCKWORK UNIVERSE

While previous time-keeping methods (sundials, water clocks) presented an essentially natural view of time which literally flowed⁸ and changed with the seasons, the mechanical clock removed time from its relation to nature, making it an abstract quantity and dividing it into increasingly smaller mathematical units. The clock also brought about a shift in the way time was perceived - the subjective view of time as something that is lived through was overshadowed by the objective view of time as something that happens. This gradual process of abstraction and objectification initiated by precise mechanical time-keeping was both a precondition for and precursor to modern scientific experimentation⁹.

Early scientific thought was centrally based on the borrowed Platonic doctrine that the universe was rationally created by a supreme being according to mathematical principle and was therefore mathematically understandable. This view of the physical world meshed quite well with the view of time presented by the mechanical clock.

The prime example of this would be the astronomical clocks, of which the earliest known example is the Dondi Instrument. Constructed in 1364 and named for its builder Giovanni de'Dondi (whose father Jacopo invented the clock face), this device consisted of, in addition to a standard clock, geared mechanisms for moving models of the Sun,

Moon, and planets around the Earth (which was of course the center of the universe) and a perpetual calendar for tracking all fixed and movable religious festivals.

Even more detailed is the astronomical clock of Strasbourg, originally constructed in 1352 and rebuilt in 1574. Aside from the standard time-keeping clockwork, it includes a perpetual calendar showing all movable feasts, and a planetarium showing the movements of the visible planets, phases of the moon, eclipses and the precession of the equinoxes. The inner dial shows the dominical letters and saints' days. The quarters of the hour are struck by figures representing infancy, adolescence, adulthood, and old age. At noon, the twelve Apostles in procession are blessed by Christ; an iron rooster flaps its wings and crows. A chariot emerges carrying the pagan deity for whom the day of the week is named. Everything, from the Copernican planetarium to the allegorical figures representing the life of a human being to the history and pre-history of Christianity is run on interconnected clockwork mechanisms. In this manner, it is the most telling of the astronomical clocks, a complete mathematical/mechanical model of what was thought to be a completely mathematical/mechanical universe.

COMMUNICATION TRANSPORTATION

Anyone who has ever traveled between two or more time zones and taken a few moments to think about it has probably noticed that there is an inherent relation between what time it is and where you are.

It's an odd realization to come to, but it is by no means new; this knowledge has been with humanity since an unknown Greek inventor built the first astrolabe circa 150 B.C.²⁰

An astrolabe consists of a disc (usually hung by a ring) with a rotatable alidade (a diametrical rule with sights) on one side; on the other side is a star map with named pointers to show the position of the brighter stars in the sky on every day of the year. By measuring the height of the sun or a star and performing some simple calculations, time or latitude could be determined, provided that one was already known.

Along with most of Greek civilization, the astrolabe faded into obscurity and was then resurrected in fourteenth century Europe where

it gained considerable use in determining latitudes, at first on land, and by the fifteenth century, at sea as well.

A curious idea, also Greek, was rediscovered along with the astrolabe at that time, namely the idea that longitude as well as latitude could be determined using a time-keeping device. The idea was that if the Earth takes twenty-four hours to turn three hundred and sixty degrees, each hour is equal to fifteen degrees and each degree is the equivalent of four minutes. For example, say you left Greenwich at noon; if, after an hour of traveling in the same direction, the sun was at the same position in the sky as it had been when you left (i.e., technically, it was still noon), then you've traveled fifteen degrees of longitude. This was a timely theory, as increased international commerce was creating a need for more accurate maps and more controlled sailing routes. The problem was, there was no clock small enough to be put aboard a ship, let alone accurate enough to make as precise a determination as was needed.

It wasn't until 1759 - almost ninety years after the first efforts had been made - that an effective clock for use at sea was developed. Its builder was John Harrison, a British carpenter and self-taught clock maker. By alternating between steel and brass for the interconnecting gears, Harrison managed to eliminate almost all friction in his five inch diameter clock and compensate for temperature changes and humidity; the differing rates of expansion and contraction in the two metals effectively canceled each other out.

Of course, there was no fixed prime meridian, and each nation operated under the assumption that its capital was the zero-degree point. As a result, a map produced in one country had to be corrected for use in another country. The state of affairs persisted for over one hundred years; we'll return to it in a few pages.



Meanwhile, back on land, time postal system²¹ was undergoing some of the same changes which faced every other endeavor involving time-keeping and/or scheduling. Delivery times had previously been measured in days or half-days, now they were

being measured in hours.

Circa 1380 in Milan there appeared "hour-passes" for use by the post. These were forms on which departure times from individual stations along a postal route were marked. In this way, those utilizing the post were able to insure that the delivery of their letter or package was made with the utmost haste and delayed not one minute by laziness on the part of the couriers.

Under the Hapsburg dynasty and their official postal service (the Taxis family couriers) an increasingly large and dense area of coverage (the Hapsburgs held lands in Rome, Austria, the Netherlands and France) was provided with an



Astrolabe, 1574

increasingly faster rate of postal service. The Taxis established fixed delivery and pickup times, mainly by requiring their couriers to ride a set distance per hour. Tardiness or any deviation from schedule was punished by a reduction in wages; particularly urgent packages were often accompanied by the threat of hanging for the courier if they were late²².

The Hapsburg dynasty and the Taxis postal service eventually collapsed in the second half of the sixteenth century; the Taxis, however, made a comeback after the German empire had stabilized. In 1595 Leonard von Taxis was appointed Chief Postmaster General by Rudolph II and the era of

postal reform was ushered in.

What postal reform basically meant was a denser coverage of an expanded area and, as these reforms were being financed by the conveyance of private as well as official mail, an increase in the volume of mail being handled. This, of course, required the building of new routes and the coordination of these routes; this led to even tighter scheduling, which brings us back to the increasingly precise and portable clocks, which every Taxis family courier regularly consulted as if their lives depended on it.

In the eighteenth century, after the Thirty Years War had come to an end, individual states began to establish their own postal services. The motivations were partially out of a mistrust for the Imperial Post and partially because of the obvious profitability of the enterprise, which had expanded to include the use of carriages for the transport passengers and large packages. The subsequent increase in and standardization of road construction along with improved wheel design resulted in the now-prominent postal carriages exceeding the speed of the mounted couriers traditionally employed. This high speed dense traffic called for a level of punctuality and synchronization which was completely unfeasible given that every town was running on a different local time.

There was nothing faster than the carriage post until the second quarter of the nineteenth century when the steam powered locomotives began rolling down tracks (which had often been laid alongside the postal roads) at three times the rate of speed of the average postal carriage. The trains of course met with the same problems - varying local times and difficulties in synchronizing them all - but to a greater degree given their much higher rate of speed. At first, most trains kept the time of their point of origin, with the result that many towns began keeping multiple public clocks, one set to local time and one for each rail company servicing the area.

European rail times rapidly became standardized, however, with railways adopting the local times of the nations' capitals as their operating standards. Due to the sheer size of the U.S., things were not so simple. Railways in the

States also kept local times, but too much area was being covered to simply standardize; as a result there were approximately eighty different railroad timetables in use.



Some relief for the problem of synchronizing regional times in the U.S. and national times in Europe came in the form of the telegraph. By 1852, only thirteen years after its invention, telegraph lines had been laid along railroad tracks around the world and were transmitting observatory time signals to railroad, postal and government offices and private subscribers (usually clock and watch manufacturers).

This didn't solve the problem of nationally coordinated time-keeping in the U.S., however, which led to the idea of the time zone. The plan was the work of one Charles F. Dowd and was first presented to the national legislature in 1869. Dowd's idea was to divide the country into four zones, each covering fifteen degrees of longitude or one hour. Originally, Washington, D.C. was to serve as the prime meridian, but was abandoned in favor of Greenwich.

Dowd's plan originally met with resistance from local politicians around the country who, as a matter of civic pride, did not want to abandon their local times, but the plan was eventually lobbied into effect. Observatories began sending the new time signals on November 18, 1883. By the end of the year, England, Sweden, the U.S., and Canada had time zones of fifteen degrees with Greenwich as the prime meridian; for mapping and navigation purposes, Greenwich was being used as zero degrees longitude by two-thirds of the world.

The following year saw the International Median Conference in Washington D.C., with delegates from twenty-five countries in attendance. Twenty-two voted to accept Greenwich as the prime meridian and enact a plan to divide the globe into twenty-four fifteen degree time zones. Fifteen years later, in 1899, radio was invented, and in 1905, the first radio time signals were broadcast from Washington D.C.; combined with the recently adopted time zone plan, radio had made world

wide synchronization possible. Everybody, finally, was on the same schedule.



NOTES:

¹ The custom of dividing the day and night into twelve parts each originated with the Babylonians, who also defined an hour as one twenty-fourth of the day, thus making them the originators of the concept of twenty-four equal hours. This idea was completely ignored until the Middle Ages, when the mechanical clock was invented.

² One such device, discovered at the Temple of Ammon in Karnak, was shown by recent tests to have a daily error of only fifteen minutes, making it much more accurate than the early mechanical clocks.

³ This dubious invention is attributed to Plato, who supposedly used to awaken the students at his academy.

⁴ This custom was derived from a Roman civic tradition which divided the day into quarters. The third, sixth and ninth hours would be announced publicly and marked, respectively, the beginning, middle, and end of the business day.

⁵ Psalm 119, verse 164: “seven times a day I praise thee” and verse 62: “At midnight I rise to give thee thanks.”

⁶ The word clock derives from the Latin *clocca*, meaning bells.

⁷ All other mechanical devices in use at the time were powered by wind or water. The clock was the first to be powered by gravity.

⁸ Although records of the verge and foliot are common throughout the fourteenth century, the oldest surviving example of the mechanism is the Salisbury Cathedral clock built in 1386.

⁹ ‘Foliot’ was derived from a word meaning

quivering leaf. Other terms used for the device were “restlessness” and “women’s temperament.”

¹⁰ Other factions of Christianity have been less accommodating to the clock. For example, the Greek Orthodox Church did not allow mechanical clocks in any of their buildings until this century, believing the device to be blasphemous as it diverted human attention towards the here and now and away from eternity.

¹¹ Eight years later, the Italian clockmaker Jacopo de’Dondi invented the twelve-hour clock face, which adorned the second known twenty-four hour striking clock in Padua. Prior to this, most clocks, had six-hour faces, if they had faces at all.

¹² This produces the now familiar ‘ticktock’ sound.

¹³ It is worth noting that after acquiring clocks many cities would rearrange their daily schedules slightly to allow events to coincide with the ringing of the hours.

¹⁴ This text also suggests “placing devices which measure time” in public, easily visible areas in libraries “so that we can see time itself flowing and fading away.”

¹⁵ At this point in time, the selling of one’s own free time was theologically acceptable; however, the selling of “time belonging to all” (i.e., the charging of interest on loans) was looked upon as downright sinful. Time was, according to Church doctrine, one of God’s gifts to humanity and was not to be mingled with financial issues. This particular piece of Christian doctrine dates to the Council of Nicaea (325) where it was declared that clerics were not allowed to charge interest on loans. In 444, Pope Leo I expended the law to include all Christians. As we all know, this particular piece of canonical law is no longer in effect.

¹⁶ In other words, it was the length of the working week, not the length of the working day, that was fixed.

¹⁷ There is no daylight in a mine-shaft.

¹⁸ “Like sands through the hourglass” or water, or a shadow as the sun moves across the sky.

¹⁹ I.e., the ever-popular scientific method still being taught in schools today. While experimentation was taking place before the clock became a common enough piece of technology, it was necessarily limited; without a precise means to measure time, quantities such as velocity, acceleration and force are impossible to measure.

²⁰ Assuming that the date is correct, this would make the astrolabe the oldest scientific instrument in the world.

²¹ Postal systems literally are messenger systems set up as relays; couriers passed on letters, parcels, etc. to each other at designated points or posts along a set route.

²² Early Taxis hour-passes often had drawings of gallows on them to encourage couriers to keep on schedule. Eventually, the threat of hanging earned its own stylized symbol: XOX.

COLOPHON

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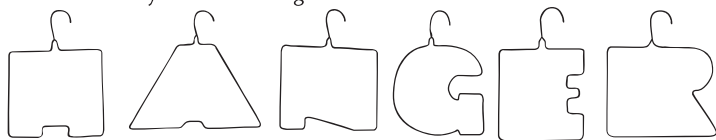


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The My Alphabet series of publications is specially designed to assist the historically challenged young people of early twenty-first century western nations to reach a broader understanding of certain things they may encounter in everyday life. A wide variety of commonplace concepts and topics, including but not limited to: the dictionary; timekeeping; the library; and the making of maps are vigorously researched, given deep consideration and then glossed over in a mock-academic tone (adopted by the author especially for this publication) which has caused at least one reader to remark, "It gave me a headache."

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