# From the Beginning

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The world-wide economic value of weights and measures is self-evident. Global acceptance of counting standards, weights and measures, and time keeping is a human success. Yet, a cursory review will reveal more than just economic benefits. By excavating the origins and innovations of common counting standards – a foundation of common ground is exposed. This essay will reveal the origins of our modern numbering standards, and demonstrate how these origins are derived from a human sense of practicality and necessity. Three numeric milestones are mapped onto a relevant timeline: from the river basins of ancient Egypt and Babylon; to the last vestige of the Roman Empire in Constantinople; and our shared American experience. By mapping these numerical milestones on a timeline, humanity's original and enduring common ground is place on display in this textual museum.

Around 2.3 million years ago a species of man named Homo Habilis (handy man) manufactured primitive tools; subsequently Homo Erectus (upright man) walked on two legs and controlled fire; today Homo Sapiens (wise man) has entered space (Britannica). It is safe to assume that the time expanse of "2.3 million years" has very little meaning to the average person[1]; the number requires context. Sixty seconds of time is all that is

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[1] J. Paul Getty - If you can count your money, you don't have a billion dollars. (Brainy)

necessary (considering: sixty seconds equals one minute; and 86,400 seconds equals one day [trust me]). Now, please imagine a Paleolithic cave drawing of a bison. The one in the Chauvet Cave of Southern France is estimated to have been created somewhere between 30,000–28,000 BCE[2]. (Now, the coup de gras: by making ticks-of-a-clock analogous to very large numbers a revelation of scale can be experienced.) One trillion seconds of time is equal to 31, 709 years[3]. The cave drawings in southern France are one trillion seconds old[4]. The magnitude of one trillion should now be imbued with scale. Our current human existence is one trillion seconds old.

According to Karl Petruso's thesis on "*Early Weights and Measures in Egypt and the Indus Valley*", he cites another researcher who presented evidence that early man measured time by placing marks on bones and antlers around 15,000 years ago (Petruso, 44). Petruso himself, declares the earliest hard evidence of man using weights and measures appeared in Egypt[5] (Petruso, 45). Petruso validates at least two counting standards in Egypt, one for counting objects and one for weight notation. A ten-based system was used to count quantities of objects (Petruso, 47). Developing a ten-based counting system is as plausible as counting ten fingers on two hands; to count larger numbers just put a stone in a cup each time you count to ten. The measurement of weight presents a different circumstance. A standardized set of weights would have been used in conjunction with a "double-pan balance" scale (Petruso, 47). Without access to a

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[2] BCE, "Before Common Era", secular expression of BC "Before Christ".

[3] Also, one billion seconds of time, equals, 31 years, 8 months, 8 days, 1 hour, 46 minutes, 40 seconds; and one million seconds of time, equals, 11 days, 13 hours, 46 minutes, 40 seconds.

[4] – or there abouts when considering an additional 2000 years of CE (AD) time.

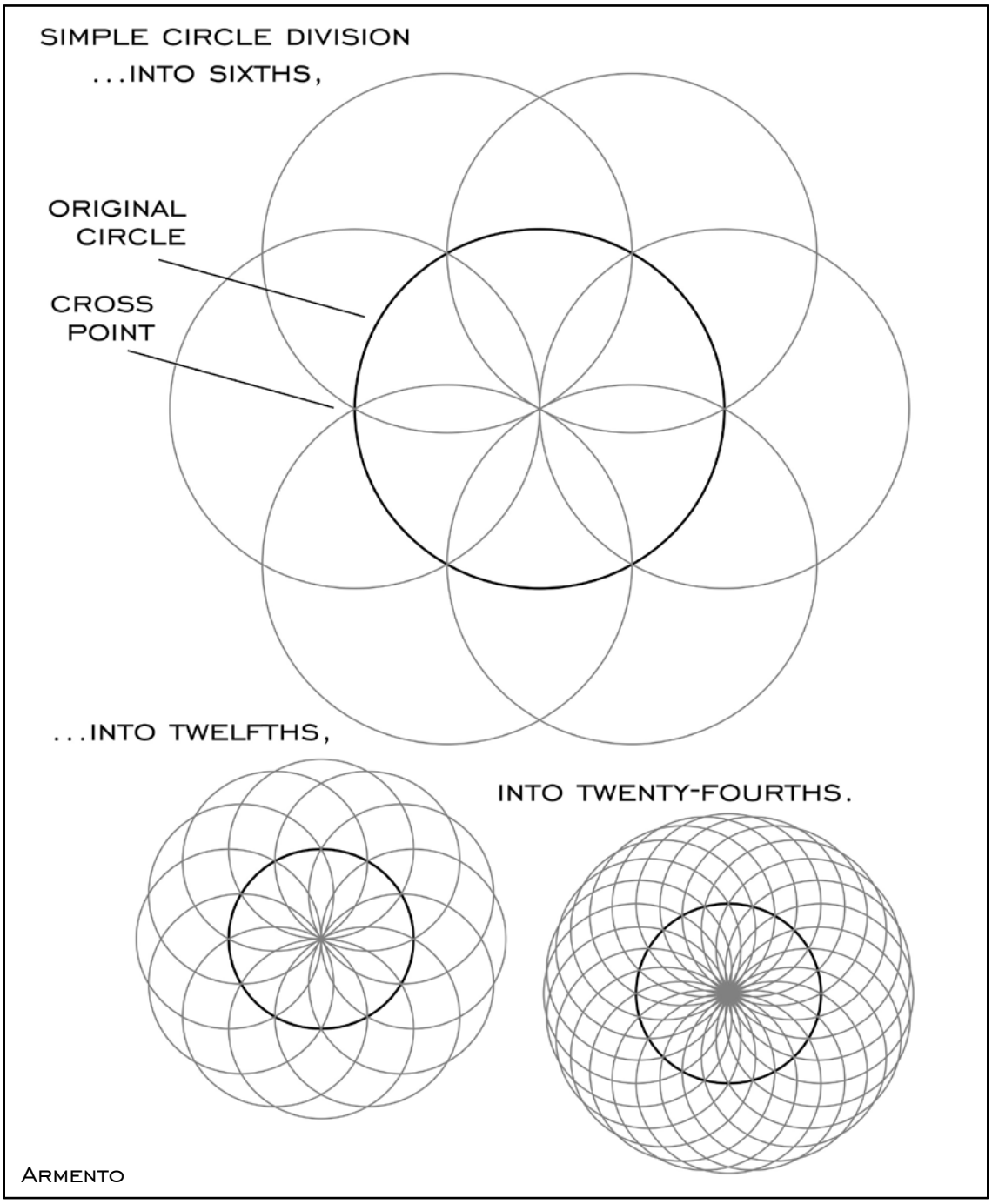
[5] The pyramids of Giza in Egypt are estimated to have been constructed between 2575 - 2465 BCE (Britannica)

standard set of weights, a two-pan balancing scale can still confidently divide quantities of grains, spices, and minerals in half. Dividing quantities of grain in half results in an interval of halves (1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64) (Petruso, 47). In this way the simple formation and origin of a common ten-based counting system and the interval of halves is revealed.

To the east of Egypt, a Fertile Crescent neighbor was counting things differently. The Babylonian counting standard was sexagesimal, a 60-based system (Swango, 4). The mystery behind the Babylonian choice of a sexagesimal system is baffling – until you hold up four fingers on your right hand and use your thumb to tap each fleshy finger segment on the other four fingers of the right hand. The thumb can touch twelve fleshy finger segments on one hand. The Babylonians were counting to twelve on one hand! Wait for it, there's more. The left hand is called the reconciling hand, and it is typically balled into a fist to start. Each time twelve is counted on the right hand, one finger is raised on the left hand. Twelve finger segments on the right hand – times – five raised reconciling fingers on the left hand, equals sixty. The mechanics of creating a counting system in early human civilizations was predicated on practicality and necessity.

In ancient Babylon, drawing a large circle was easy with a center pole and a string; just attach one end of the string to the pole, stretch the string out and walk around the pole while drawing the circle's perimeter in the ground. Or, to draw a smaller circle, one might use a stick with a pivot point on one end, and a scribe on the other end. Both drawing methods are easy, low-tech, solutions for drawing circles. As it turns out, equally dividing a circle is easy too; just draw multiple circles – of the same size – across the interior of the first circle. A center point and six evenly spaced cross points are visible

on the edge of the original circle. Now the circle can be evenly divided into six even segments; and look, a geometry flower has grown in the middle of circle division.




Draw straight lines from the circle's center point to each cross point, like spokes on a wheel; this will further divide the circle into six even pie slices (not shown). For the

Babylonians circle division with a string and a stick was too easy, so they studied the stars. Their astronomical pursuits eventually required them to divide the circular horizon by more than six pie slices. Six direction points on a compass is not granular enough to map a star above the circular horizon. So, what number would be granular enough, and also, be handy to everyone? Well, if you were an ancient Babylonian, you may be able to count up to sixty using two hands. Okay, sixty it is. Sixty evenly spaced degrees inside of each pie slice, which equals three-hundred and sixty degrees per circle. Modern navigational compasses are still expressed in this manner.

Advance the timeline from ancient Babylon to the last vestige of the Roman Empire in the city of Constantinople (formerly Byzantium). The City of Rome was sack by the Visigoths into 410 CE[6] – Europe fell into cultural darkness. The remaining eastern half of the Roman Empire was enclaved in Constantinople, it became the cultural center of all things Greek and Roman. The city of Constantinople had maritime access to the Mediterranean Sea and the Black Sea; overland access extended north into Europe and southward into the Middle East and beyond. But, without the support and prestige of Rome, the eastern half of the Roman Empire at Constantinople became an embattled empire for the next thousand years. Both Europeans and Muslims sent armies to Constantinople's walls. The crossroads of Constantinople became a crucible of cultures. During this time, a new numbering standard infiltrated the fortified walls of Constantinople, it sailed across northern Africa into Moorish Spain and started to flourish in Genoa and Florence Italy. The Hindu-Arabic numbering system was

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[6] CE, "Common Era", secular expression of AD "Anno Domini" [Latin: "in the year of the Lord].

evolutionary – it included the number zero. In 625 CE, a Hindu mathematician named Brahmagupta created a symbol for zero and performed mathematical operations using zero as a number – not as a placeholder (Wallen). The numerical concept of zero traveled westward from India into Baghdad and by 790 CE a Persian polymath named Al-Khowarizmi wrote an Arabic manuscript on the use of zero in algebraic equations (Oaks)[7]. European clergy and royalty were suspicious of Arabic numerals, some resisted the numbering system by outlawing its usage (Wallen). It would take several more centuries for Arabic numerals to be embraced by Europe. In 1202 an Italian mathematician, Leonardo of Pisa, also known as Fibonacci, produced a handwritten Latin manuscript based on Al-Khowarizmi's work. The days of Roman numerals[8] and the abacas counting frame were numbered.

During the 1400s, Europe would experience two innovations and one cultural catastrophe. Around 1450, a German goldsmith built a moveable-type printing press. Guttenberg's printing press would incrementally double the literacy rate in Europe over the next four hundred years (Roser). Print publishing became a profit center for artist and authors. At the same time, another innovation would leverage the Arabic numeral system to great effect in Italy and eventually all of Europe. The double entry bookkeeping system[9] allowed merchants and bankers to review assets and debts of any business venture with great confidence and regularity. Double entry bookkeeping created new

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[7] "*The Compendious Book on Calculation by Completion and Balancing*", by Al-Khwarizmi, circa 813–833 CE (Oaks).

[8] A Roman Legionnaire walks into a bar and holds up two fingers in the shape of a "V" and says "give me five beers." The bartender turns away and rolls his eyes.

[9] There is some academic support for double entry accounting principles being used in ancient Egypt prior to European adoption. (Gleeson-White)

classes of wealth in the Mediterranean. Merchants and bankers were new cultural power brokers and sometimes worked in contention to the old money of clergy and royalty. And, yet again, another Italian wrote another mathematics book in 1494, but this time, friar Luca Pacioli had access to a German goldsmith's printing press to make copies. The good friar is still widely celebrated as "*The Father of Accounting and Bookkeeping*". Pacioli's compendium[10] of numeric tables, formula's, and standards was Europe's meeting of the minds, arithmetic was becoming common ground amongst common people. Accounting ledgers, procedures, and standards became common enough to be reviewable by contract and the courts in matters of debt payment. The adoption of Arabic numerals (with a functioning number zero) and double entry bookkeeping by the Italian merchants and bankers fueled the Italian Renaissance (Wallen). Cultural catastrophe struck in 1453, the last repository of the Roman Empire was sacked. The fortified walls of Constantinople were breached, screams were heard, and the caretakers of all things Greek and Roman scattered back into the embrace of an awaiting Italy and the best Renaissance fair of all time!

Two new continents were discovered at the end of the 1400s, all you had to do was sail further west than anybody else and make it back home. Time was still measured with a calendar. The next four hundred years of the western culture were the best of times and the worst of times. Watches and clocks developed mechanical precision in the 1500s (Britannica). Cities built clock towers that chimed the hours of the day. The

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[10] "*Summa de Arithmetica*" by Luca Pacioli. (Summary of arithmetic, geometry, proportions and proportionality).

measure of time and the plodding tick of the clock became another medium of common ground.

In his thesis "*Early Weights and Measures in Egypt and the Indus Valley*" Karl Petruso suggests that a "consistency of standards is often taken as an indication of [a] strong central market authority" (Petruso, 50). Today, we use the interval of halves (1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64) as the agreed measure of all things binary, like a 64 MB memory stick, cell phones, and computers. Music notation uses the same interval of halves to transform the human condition (arpeggiating four piano chords with 64th notes can evoke a sense of dreamy delirium and hand cramps at the same time). It is tangentially ironic that the Metric System does not express music notation – given the fact: the Metric System uses a ten-based counting system to measures just about everything else (length, distance, weight, volume, and temperature). America inherited Imperial Units from England. The Imperial collection of measurements is a mashup of 12, 16, and 32nd numeric intervals. (Inch, foot, and yard measure distance; ounces and pounds measure weight; and the Fahrenheit scale measures temperature). When measuring distances below an inch, Imperial measurement relies on the interval of halves (1/2, 1/4, 1/8, 1/16, 1/32, 1/64 of an inch). Three countries still use Imperial Units: United States, Liberia, and Myanmar (England uses a mix of Imperial and Metric). The rest of the world has adopted the ten-based Metric System[11].

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[11] This international difference is not without consequences. In late September of 1999, NASA's crashed the $125 million Mars Climate Orbiter (MCO) into the planet Mars. It was later determined that the thrust deceleration numbers for landing on Mars were not converted from Metric to Imperial. (Harish)

The hard-earned advancements of Homo Sapiens seems to be founded upon our capacity to count on fingers, divide things in half, and draw circles. Each counting standard is derived from a human sense of practicality and the necessity for mutual a standard. This is our common numerical ancestry. Arithmetic and mathematics without borders – is – our common ground. Blam![12] [mic drop] Paraphrasing, "each of us drinks from wells we did not dig, and each of us are warmed by fires we did not build".[13] Clearly, this notion is now self-evident.

## Works Cited

Brainy, Quote. "J. Paul Getty Quotes." BrainyQuote, Xplore, https://www.brainyquote.com/quotes/j_paul_getty_161394

Britannica, Editors of. "Homo, hominin genus." Encyclopedia Britannica, Inc., https://www.britannica.com/topic/Homo

~~~~~ "Pyramids of Giza." Encyclopedia Britannica, Inc., https://www.britannica.com/topic/Pyramids-of-Giza

~~~~~ "Watch, timekeeping device." Encyclopedia Britannica, Inc., https://www.britannica.com/technology/watch

Dore, Gustave. "Sunset in Eden (Milton's Paradise Lost)". 1880. Cover art (cropped).

Gleeson-White, Jane. "Double Entry". W. W. Norton. (2012). p. 294.

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[12] Onomatopoeia, (Wikipedia). [Easter Egg. Title of this Paper & soundtrack. Emerson Lake and Palmer - From the Beginning] https://youtu.be/a9kXfW2gIcw

[13] Old Testament verse. Deuteronomy 6:11, [KJV] "houses full of all good things, which you did not fill, hewn-out wells which you did not dig, vineyards and olive trees which you did not plant—when you have eaten and are full".

Harish, Ajay. “How NASA Lost a Spacecraft from Metric Math Mistake.” SimScale, 2021 https://www.simscale.com/blog/2017/12/nasa-mars-climate-orbiter-metric/

Oaks, Jeffrey A. “Polynomials and Equations in Arabic Algebra.” Archive for History of Exact Sciences, vol. 63, no. 2, 2009, pp. 169–203. JSTOR, www.jstor.org/stable/41134304. Accessed 5 Mar. 2021.

Petruso, Karl M. “Early Weights and Weighing in Egypt and the Indus Valley.” M Bulletin (Museum of Fine Arts, Boston), vol. 79, 1981, pp. 44–51. JSTOR, www.jstor.org/stable/4171634 . Accessed 18 Feb. 2021.

Roser, M. and Ortiz-Ospina, E. (2019). Literacy. Our World in Data. https://ourworldindata.org/literacy#historical-change-in-literacy

Swango, Lynn, "A Brief History of Weights and Measures" (1957). Plan B Papers. 56. https://thekeep.eiu.edu/plan_b/56

Wallen, Nils-Bertil. “The History of Zero.” November 19, 2002 https://archive-yaleglobal.yale.edu/history-zero

Wikipedia.com “Blam (Lichtenstein)”, https://en.wikipedia.org/wiki/Blam_(Lichtenstein)

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