

Counting Sheep


A Brief History of Written Numbers





One way to write a number is to spell it out in alphabetic characters, just as one would write any other word: o-n-e. Other methods of numerical notation, however, include non-phonetic signs, which, unlike the alphabet, do not aim to reproduce the spoken word. This essay is about the relation between writing and numbers: to examine the history of numerical notation is to challenge a few basic assumptions about the nature of writing.




Many historians view phonetic scripts as the most advanced stage in the development of writing. The roman alphabet is an attempt to analyze the innumerable sounds of speech into a couple dozen signs, suited to being carved in stone or drawn on paper, and capable of indefinite preservation. Most definitions of writing take the physical permanence and phonetic fidelity of the alphabet as their model: a form of communication only qualifies as “writing” if it is a representation of speech, capable of being read back orally, as a series of words, one after the other. Writing is assumed to be *graphic*, consisting of lines drawn on a flat plane.



Techniques for visualizing numbers tend to appear in cultures long before efforts to reproduce the full spoken language. A look at several early forms of numerical notation reveals a fluid range of forms through which human cultures have attempted to depict the order—numerical and linguistic—of the world. Many of these visualizations employ concrete objects rather than graphic marks, including sticks, stones, beads, furniture, and the human body. Writing is commonly described as an inferior, *secondary* copy of the immediate, intuitive spoken word; some early representations of number, however, show that a culture’s choice of symbols helps structure its verbal number sequence. In these cases, writing helps *give form* to the spoken language, rather than passively reproducing it.


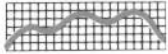



Since the Renaissance, the infrastructure of Western civilization has consisted largely of paper. Modern Hindu-Arabic numerals appeared in India between the sixth and eighth centuries A.D., but they did not begin to compete with finger counting and the abacus in Europe until the fifteenth century: calculations on paper ultimately replaced calculations with objects. The fifteenth century also witnessed the introduction of movable type in Europe, and with it, the rise of the book and a growing dependency on paper. During the twentieth century, radio, television, and electronic media have shaken the supremacy of the book. We may find, in the multiple modes of representing numbers, an expanded definition of writing.

The English word *score* means “a cut or indentation” it also refers to the number twenty. The word gets its double meaning from an object called a tally stick, a length of wood or bone marked with a series of scratches . The twentieth cut on a tally stick is sometimes called a score. Tally sticks have appeared in literate and non-literate cultures from prehistory to the present; they keep time, count objects, and record credits and debts.







In the simplest form of tally, one notch is made for each item recorded: to count five sheep , a shepherd might make five scratches on a stick . This principle is called *ordering*: there is a one-to-one correspondence between the set of symbols and the set of objects counted. Ordering is also at work in modern dice, where  equals five, and in playing cards, where  is the five of diamonds.

The principle of *grouping* arranges an ordered collection of signs into smaller sets. Groups on a tally stick might be indicated with larger and smaller cuts , or straight lines and diagonals . In a tally convention familiar today,  represents five single strokes grouped in a bundle.

The ancient principles of ordering and grouping have no relation to spoken numbers, arising not from the will to record speech but from the need to keep track or “keep score” of objects or events. Whereas the Hindu-Arabic symbol 3 corresponds with the spoken number “three,” a particular tick on a score pad, such as the third mark in the series , is a graphic substitute for an event (the counting of a ). Linguists call this kind of mark *indexical*: there is a relationship of cause and effect between the sign and its referent,





as in foot prints  or a curve mapped on a graph . The figure X, for example, is not only a phonetic letter but a sign in its own right, serving as a record or “index” of events: X stands for a signature , or X signals an act of  selection or an act of deletion . X is also the roman numeral for ten.

Roman numerals were the dominant written numbers in Europe from the period of the Roman empire until the rise of the Hindu-Arabic system. Employing the principles of ordering and grouping, roman numerals consist of a graphic symbol for each power of ten (I, X, C, M), and for each subdivision of five (V, L, D). The numeral III represents three as one one one, and CCC represents three hundred as hundred hundred hundred.

The forms of the roman numerals coincide with the characters of the roman alphabet, but they may actually derive from tally markings. In tallies, a single vertical mark  commonly represents one, while two diagonal cuts, such as  or , stand for five, and a crossed stroke, such as  or , indicates ten. The roman numeral D is half of the symbol , an ancient form of the sign for one thousand. The roman numerals may thus originate from a pre-alphabetic style of writing.

“After all the natural way to count is not that
one and one make two
but to go on counting by one and one....
One and one and one and one.
That is the natural way to go on counting.”

GERTRUDE STEIN

The English word *calculate* comes from the Latin *calculus*, meaning “small stone.” Like tally sticks, stones are an ancient counting tool which, in their simplest application, require no verbal number sequence to operate: one stone is collected  for every object counted . A counting technique used by the Sumerians beginning around 8000 B.C. involved small “tokens” manufactured out of clay . Invented during the period when agriculture was supplanting an economy of hunting and gathering, tokens probably recorded business transactions between such parties as the temple government and a shepherd in charge of some .



Groups of tokens dating from around 3200 B.C. have been found enclosed in sealed clay envelopes. The shapes of tokens were impressed into the clay container, one sign for each token. Thus the envelope could be read without being cracked open—the three-dimensional tokens inside offered a hidden guarantee for the graphic signs on the outside.
















Soon, however, the marks impressed into the envelopes replaced the tokens altogether, and records were kept on small clay tablets instead. The production of tokens appears to have ceased around 3100 B.C., when a system for graphically recording the spoken language was emerging in Sumeria. The new script retained some symbols from the older token system, but a basic conceptual change took place.

“What is logic?

To me two and two equals twenty-two, not four.”

MAN RAY

Each token had represented a quantity of a particular product: a clay disc marked , for example, stood for , and could not be used to count any other kind of object. The collection  signified : number and object were fused together. The new writing system, however, paired a separate number symbol with a sign for the object, so that  meant five . The number symbol , meaning five, might be paired with the sign for any object. Number was now independent from things: with the rise of written language came a move away from concrete thought and toward abstraction.

Modern English contains a few words that signify a plurality of particular objects: a flock of , a herd of , or a school of . The English word *pair* names objects or groups of objects to which doubleness is a natural state: a pair of , a pair of , a pair of . Modern Japanese has separate “number classes” for different objects; words called “counters” are inserted between the number word and the name of the object counted: for example, *dai* for vehicles, *hai* for glassfuls, *ma* for rooms, *mai* for thin, flat objects, *hon* for long, cylindrical objects, *go o-sya* for train car numbers, and so on. Linguists consider conventions such as these remnants of an older, less abstract stage of thought, which conceived of number as an integral characteristic of the objects being counted.

“The depicting of objects

is appropriate to a savage people;
signs of words to a barbaric people;
and the alphabet to a civilized people.”

J. J. ROUSSEAU

Most verbal number sequences are organized into groups of ten; they are called “base ten.” A number sequence can be devised with any other base, such as five or twelve; digital computers, for example, use base two numbers, which employ the most minimal set of symbols possible, zero and one, on and off. Yet no culture has been known to spontaneously generate binary numbers; most cultures use ten. Why would the human mind be almost universally compelled to

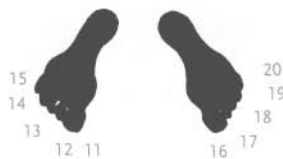
generate number sequences
with a base ten structure?



The answer lies not in
the mind but in the body.

Human hands, equipped with ten fingers, are convenient devices for counting and calculating. Numerous cultures use the hands and feet, fingers and toes, as the basis of number systems. Aztec numeration is base twenty; thus thirty is expressed verbally as “twenty plus one,” and forty is “two times twenty.”

The modern French word



quatre-vingt, which means
“four twenties,” is equivalent

to the English eighty. The human body readily suggests counting in fives, tens, and twenties: our word *digit* comes from the Latin *digitus*, meaning “finger or toe.”

Europeans initially distrusted the zero.
A fifteenth-century French writer complained,

“Just as the rag doll wanted to be an eagle,

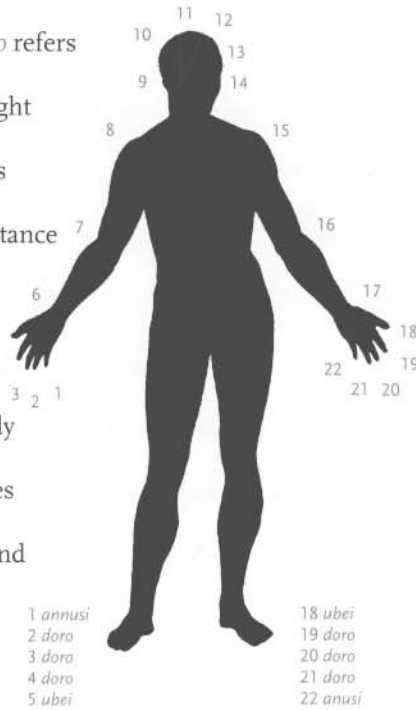
the donkey a lion,

and the monkey a queen,

the *cifra* [zero] put on airs and pretended to be
a digit.”

The whole body can become a set of symbols for representing numbers. A technique used by the Papuan natives of the Torres Strait assigns numerical values to positions on the body. The verbal words identifying the numbers are each names for body parts, and some of the words appear more than once.

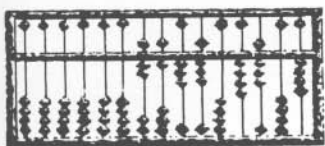
For example, the word *doro* refers to fingers from both the right and left hands, and thus its numerical value in any instance would be made evident only if the “speaker” were also pointing to a body part. Thus the verbal names have a nonverbal source, and cannot function alone.



In its simplest form, finger counting relies on the principle of ordering: seven fingers for seven sheep. In the body system at left, each body part stands for a unique step in a sequence; it represents a *position* in a series rather than a concrete object. In Europe, hand counting systems capable of

representing numbers in the thousands and tens of thousands were widely used until the ascendance of Hindu-Arabic numerals; the body provided a numerical vocabulary “spoken” by hand in both the monastery and the marketplace. Writing is generally defined as a method for depicting *speech*, yet the recurrence of the base ten sequence suggests that when representing numbers, speech followed an example offered by non-verbal expression.

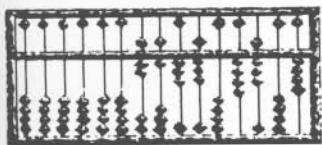
The *abacus*, used for counting and computing in ancient Greece and Rome, remained powerful until the rise of Hindu-Arabic numerals during the Renaissance. The abacus has had a longer life in China and Japan, where it is still used alongside the electronic calculator.



7 6 3 8 0 4 8 0 4

On an abacus, each string of beads represents a power of ten, and each bead is a unit. The horizontal division indicates groups of five, allowing a number to be represented with fewer beads. Adding and subtracting with an abacus involves manipulating physical objects rather than abstract signs—the concreteness of the abacus makes it useful for teaching children arithmetic.

The Latin word *abacus* also means “table”: an abacus often consisted of a table that was cut with grooves or simply marked with chalk lines, on which discs called “counters” were



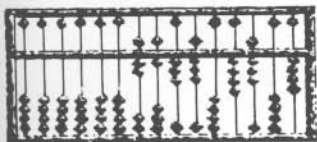
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moved about. Called “counting tables,” such numerical furniture was used widely throughout Europe for both commercial and scholarly arithmetic. Like Hindu-Arabic numerals, an abacus indicates

powers of ten by position. A major difference between the abacus and Hindu-Arabic numerals is how to represent the *absence* of digits in a power of ten. The abacus achieved this quite sensibly: an empty column. The Hindu-Arabic system could not use an empty column, however, because a gap in a row of digits would indicate two distinct numbers.

Thus a symbol was invented to represent an empty set: the zero.

The Hindu-Arabic system became the numerical equivalent of the alphabet: abstract, concise, graphic. With the rise of the new numerals, the tradition of “writing” with objects began to disappear.

ZERO
ZERO

SOURCES This essay relies on Georges Ifrah, *From One to Zero: A Universal History of Numbers* (New York: Viking Penguin, 1981, 1985), and Karl Menninger, *Number Words and Number Symbols: A Cultural History of Numbers* (Cambridge: MIT Press, 1958, 1969). On Sumerian tokens, see Denise Schmandt-Besserat, “Tokens: Facts and Interpretations,” *Visible Language*, Vol. XX, No. 3 (Summer 1986): 250-273.