The First Information Technology: Writing Systems

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History of Information
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The First 50,000 Years...
Itinerary, 1/28

The Origins of Language
The Origins of Representational (Symbolic) Artifacts
The Variety of Signs
Proto-writing
The Origins and Development of Writing Systems
Types of Writing Systems
Independent Inventions of Writing Systems
The First "Information System": Language

Early theories: "bow-wow," "uh-oh," "pooh-pooh," etc.

1886: Linguistic Society of Paris forbids "toute communication concernante l'origine du langage" [All papers dealing with the origin of language]

No direct evidence about origins of language

No existing "primitive" languages: all modern human populations speak languages of comparable complexity.

Was development of language gradual or sudden? Does language presuppose neural modification?

language might have emerged w. Homo erectus (1.5 m years)
Or with mod. Homo sapiens (ca 100-150k years)
Or with Upper paleolithic tool-making (ca. 40-45 k years)
The Beginnings of Representational Artifacts

Cave paintings, Lascaux, France: ca 15-13,000 BC (others perhaps to 30,000 BC)

"Venus of Tan-Tan," Morocco, possibly 250k years old, but may be a naturally occurring object.

Man's first affirmation of himself, and expression of his own newness--when, by the ways and means of art, he entered into contact with the power, brilliance, and joyful mastery of a force that is essentially the force of a beginning. . . ." Maurice Blanchot
"Images and symbols… were markers of periodic and continuous cultural processes, of rites, and of repetitive myths and stories…” Alexander Marshack
"... whereas notations of whatever sort were apparently means of recording the passage of time in terms of culturally significant events."
The Varieties of Signs

3 Types of signs (after Charles Peirce): *icon*, *index*, *symbol*

**Icon**: relation of resemblance (more-or-less) to signified.
E.g.,

**Index**: stands in causal/spatial relation to the signified (blaze on tree to act of marking, thermometer to temperature)

**Symbol**: arbitrary relation between sign and signified.
E.g., written word *cat*, spoken word /kæt/.
The Varieties of Signs

**Icon:** sign stands in relation of resemblance or similarity to signified (often only roughly).
The Varieties of Signs

**Icon**: sign stands in relation of resemblance or similarity to signified (though often only roughly).
The Varieties of Signs

BEACH CONDITIONS

These conditions may exist at any time.
The Varieties of Signs

BEACH CONDITIONS

WARNING
DANGEROUS SHOREBREAK
Waves break in shallow water.
If in doubt, don’t go out.

WARNING
HIGH SURF
Can cause serious injuries or drowning.
If in doubt, don’t go out.

WARNING
STONG CURRENT
You could be swept away.
If in doubt, don’t go out.

WARNING
MAN-O-WAR
Stings are painful.
Stay out of water.

WARNING
JELLYFISH
Stings are painful.
Stay out of water.

WARNING
SUPPORT ROCKS
You could fall and be injured.
If in doubt, don’t go out.

WARNING
SLEDON DROP OFF
Rocks drop off abruptly.
If in doubt, don’t go out.

WARNING
SHARP CORAL
May cause serious injury.
Avoid contact.

These conditions may exist at any time.
Early Iconicity

Petroglyphs, Scandinavia, Bronze Age

Rock carving, Hong Kong (Kau Sai), 3000 BC

Petroglyphs, Bhimbetka, India, ca 9000 BC
The Varieties of Signs: Indexical

**Index:** stands in causal/spatial relation to the signified (pawprint to bear, blaze on tree to act of marking, thermometer to temperature)
Early Indexical Signs

Earliest signs are mnemonics for record-keeping, genealogy, etc. (Tallying systems)
Knotted rope, notched stick or bone, etc.
Become frequent in upper paleolithic

Notched Bone, England, upper paleolithic, 12,000 years old
Notched Bone, Turkey, ca 3000 BC
Notched bone, Congo, ca. 25,000 BC -- may represent lunar calendar
The Varieties of Signs: Symbols

Arbitrary (or effectively arbitrary) relation between sign and thing signified

tree
The Varieties of Signs: Symbols

Arbitrary (or effectively arbitrary) relation between sign and thing signified

Were there paleolithic symbols?
Elaborated Indexical System: The Inca qipu

Knots of varying colors in llama or alpaca hair;

Sequences recorded population, taxes, geneology, astronomy (and possibly names) in decimal system. System maintained by knot-keepers.

Limits: can record only quantity and category; requires extensive convention for intepretation
Pictographic (Iconic) Communication Systems

Fig. 4.—Geometrical forms. (From a photograph of rocks).
Pictographic (Iconic) Communication Systems

Kiowa message to the US President
"The chief salutes the president, and his warriors belonging to the eagle and catfish totems are in harmony with him and are willing to accept the white man's ways."
Pictographic Systems

Yukaghir (Siberia) “love letter,” late 19th c.
"Pictographic" Systems

"I know you're fighting with that Russian girl you broke up with me over. I'm unhappy in my house as I think of you, but you should know there's another guy hitting on me, so get on the stick before I get married and have children."
Ideographic (Semasiographic) Systems: the importance of context

"Turn the key. If the car is cold, don't step on the gas pedal; if it's warm, depress the gas pedal halfway as you turn the key."
An Aside: The 10,000-year warning

Sandia Labs: warning signs to last 10,000 years for radioactive waste dumps.
The 10,000-year warning
Abstraction in pictographic systems

Extending pictographic systems to deal with abstract or relational notions. E.g., "brother," "go," etc.

A step toward the development of "true" writing:

Form signs for abstract entities by extending or combining signs for concrete things (ca. 3300 BC)

- foot = "go, come, walk, etc."
- person + mountain = "foreigner"
- eye + water = "weep" etc.

Cf modern use of "metonymic" icons
The limits of ideographic/semasiographic systems

Semasiographic system: symbols stand directly for ideas, not for words of a language,

In theory, semasiographic systems could communicate a full range of information without reference to spoken language. Cf mathematical notation:

\[ 10^9 = 1,000,000,000 \]

"Ten to the ninth equals a billion."/ "Zehn hoch neun gleicht eine Milliarde," "Dieci alla nona potenza equivale a un miliardo," etc.

\[ \forall x \ (Fx \rightarrow Gx) \]

"For all x, if F of x then G of x"/"Everything that is F is G," etc.

But language-independent systems appear inadequate to express the full range of thoughts & information (as opposed, e.g., to artificial languages.)
The origins of true writing

Glottographic writing: rather than referring directly to reference/ideas, signs are associated with elements of the language (words, morphemes, syllables, phonemes).

Cf "5" vs five," cinque, wǔ, etc. "$" vs "dollars," etc.
Origins of Writing in Sumer

Bullae and tokens

Early cuneiform
Origins of Writing in Sumer

8-5000 BC -- earliest use of clay tokens.
4,000 BC -- earliest clay bullae
3500-3300 BC -- earliest clay tablets from Uruk.

Bullae and tokens

Early cunieform
Tokens as origins of Sumerian writing?

![Table of evolution from token to cuneiform writing](image)

<table>
<thead>
<tr>
<th>Token</th>
<th>Pictograph</th>
<th>Neo-Sumerian</th>
<th>Neo-Assyrian</th>
<th>Neo-Babylonian</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Sheep</td>
</tr>
<tr>
<td>Cattle</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Cattle</td>
</tr>
<tr>
<td>Dog</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Dog</td>
</tr>
<tr>
<td>Metal</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Metal</td>
</tr>
<tr>
<td>Oil</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Oil</td>
</tr>
<tr>
<td>Garment</td>
<td><img src="image" alt="Pictograph" /></td>
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<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Garment</td>
</tr>
<tr>
<td>Bracelet</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Bracelet</td>
</tr>
<tr>
<td>Perfume</td>
<td><img src="image" alt="Pictograph" /></td>
<td><img src="image" alt="Neo-Sumerian" /></td>
<td><img src="image" alt="Neo-Assyrian" /></td>
<td><img src="image" alt="Neo-Babylonian" /></td>
<td>Perfume</td>
</tr>
</tbody>
</table>

*Figure 7* Pictographic tablet from Uruk, Iraq, late fourth millennium B.C. The account in the upper central case, for example, shows the sign for sheep and five wedges standing for the abstract numeral. Courtesy Vorderasiatisches Museum, Staatliche Museen zu Berlin, East Germany.
Origins of Writing in Sumer

2500 BC -- cuneiform “true” writing
2400 BC script used for Akkadian
2000 BC script used for Babylonian & Assyrian..
1750 BC Code of Hammurabi
Functions of Early Writing

Writing develops as memorial aid -- things that are hard to remember…

- Commercial records
- Calendars & dates

Or that have to be said just so:

- Titles
- Laws/proclamations
- Liturgical texts
- Poetry
Origins of Writing in Sumer

Epic of Gilgamesh (7th c. BC)

He who saw everything in the broad-boned earth, and knew what was to be known
Who had experienced what there was, and had become familiar with all things
He, to whom wisdom clung like cloak, and who dwelt together with Existence in Harmony
He knew the secret of things and laid them bare. And told of those times before the Flood
In his city, Uruk, he made the walls, which formed a rampart stretching on…

Epic from ca. 1500-1750 BC, existing tablets from 600 BC in Akkadian…
Increasing Abstraction of Written Form

<table>
<thead>
<tr>
<th>Proto-cuneiform  c.3000 bc</th>
<th>Early cuneiform  c.2400 bc</th>
<th>Late (Neo-Assyrian) cuneiform c.700 bc</th>
<th>Transcription and meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Proto-cuneiform symbol" /></td>
<td><img src="image2" alt="Early cuneiform symbol" /></td>
<td><img src="image3" alt="Late cuneiform symbol" /></td>
<td>sag “head”</td>
</tr>
<tr>
<td><img src="image4" alt="Proto-cuneiform symbol" /></td>
<td><img src="image5" alt="Early cuneiform symbol" /></td>
<td><img src="image6" alt="Late cuneiform symbol" /></td>
<td>ka “mouth”</td>
</tr>
<tr>
<td><img src="image7" alt="Proto-cuneiform symbol" /></td>
<td><img src="image8" alt="Early cuneiform symbol" /></td>
<td><img src="image9" alt="Late cuneiform symbol" /></td>
<td>du/gi/gi “go/walk/stand”</td>
</tr>
<tr>
<td><img src="image10" alt="Proto-cuneiform symbol" /></td>
<td><img src="image11" alt="Early cuneiform symbol" /></td>
<td><img src="image12" alt="Late cuneiform symbol" /></td>
<td>gam “ox”</td>
</tr>
<tr>
<td><img src="image13" alt="Proto-cuneiform symbol" /></td>
<td><img src="image14" alt="Early cuneiform symbol" /></td>
<td><img src="image15" alt="Late cuneiform symbol" /></td>
<td>udu “sheep”</td>
</tr>
<tr>
<td><img src="image16" alt="Proto-cuneiform symbol" /></td>
<td><img src="image17" alt="Early cuneiform symbol" /></td>
<td><img src="image18" alt="Late cuneiform symbol" /></td>
<td>ka “dish”</td>
</tr>
<tr>
<td><img src="image19" alt="Proto-cuneiform symbol" /></td>
<td><img src="image20" alt="Early cuneiform symbol" /></td>
<td><img src="image21" alt="Late cuneiform symbol" /></td>
<td>dag “pot”</td>
</tr>
<tr>
<td><img src="image22" alt="Proto-cuneiform symbol" /></td>
<td><img src="image23" alt="Early cuneiform symbol" /></td>
<td><img src="image24" alt="Late cuneiform symbol" /></td>
<td>gi “need, to render”</td>
</tr>
</tbody>
</table>

Figure 2.2. The development from proto-cuneiform, through early Sumerian cuneiform, to later Akkadian cuneiform. Proto-cuneiform signs are often reinterpretable through and changes, as the sign for “sheep” changes.
The Origins of "complete" writing

"Complete" glottographic system: signs denote words of the language
The Rebus Principle

Rebus: Icons of things that stand in for their (phonetic) names
The Rebus Principle

Eye  saw  ewe  duck  deer

"I saw you duck, dear."
Rebus principle leads to logography

Rebus principle allows signs to be reutilized to signal abstract words, functional elements, etc.

“water” /a/ → “in” /a/

“oracle” /me/ → plural suffix /-me/

Accompanied by increasing conventionalization of signs... Creates need for “determinative” signs to indicate how other signs are being used.

Eg. “marsh plant” (/te/) sign also used for name of goddess assoc. w. marshes /eresh/ -- /u/ “plant” used to indicate “marsh plant” use of sign.
Logographs ultimately perceived as having purely phonetic value.

Cf English logographs -- imagine the word  $h@b&$

Where does this happen in modern life?
Logography to Syllabic System

Logographs ultimately perceived as having purely phonetic value.

Cf English logographs -- imagine the word $h@b&$

Where does this happen in modern life?

Signs come to stand in for syllables

Logographs ultimately perceived as having purely phonetic value.
Origins of Alphabetic Writing

Alphabetic system derived from application of syllabic system to different phonological structures.

Logographic: mod. Chinese, Japanese (mixed)

Syllabic: Linear B, Cherokee, Korean Hangul (featural)

Alphabetic: Roman, Cyrillic, Gk, Hebrew, etc,
Origins of Alphabetic Writing

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Logographic: mod. Chinese, Japanese (mixed)

Syllabic: Linear B, Cherokee, Korean Hangul (featural)

Alphabetic: Roman, Cyrillic, Gk, Hebrew, etc,

Problem with completely phonetic alphabetic systems: ambiguity.

Cf French _au_, _aux_, ô, _os_, haut, _hauts_, eau, _eaux_, _os_, etc.
Development of Written Symbols

Icon
Development of Written Symbols

Simplification of sign

Iconic

Semasiographic/ideographic

Proto-writing
Development of Written Symbols

Simplification of sign

Iconic

Semasiographic/ideographic

Rebus extension

Proto-writing
Development of Written Symbols

Simplification of sign

Iconic

Proto-writing

Semasiographic/ideographic

Rebus extension

[ɛlvIs]

logographic

"True" (glottographic) Writing
Development of Written Symbols

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Proto-writing

Iconic

Semasiographic/ideographic

Rebus extension

[εlvIs] /εl/

logographic syllabic

"True" (glottographic) Writing
Development of Written Symbols

Simplification of sign

Iconic

Semasiographic/ideographic

Proto-writing

Rebus extension

[εlvIs] /ɛl/ /ε/

logographic syllabic alphabetic

"True" (glottographic) Writing
Genealogy of Writing Systems

But evidence is slight for derivation of Chinese from proto-Sumerian
Independent Invention of Writing Systems
Sequoyah [George Gist] and the "talking leaves": 1819
Independently invented writing systems:
The Cherokee Syllabary

Cherokee Phoenix: First American Indian newspaper (1828)
Independently invented writing systems: Korean Hangul

Writing system invented in mid-15th c. to replace hanja (Chinese writing system). Invention credited to King Sejong ("the Great"), who introduced it to increase mass literacy. Possibly influenced by central Asian scripts.

Sometimes described as only "featural" system: symbols representing sounds as features (i.e., "labial," etc.) are clustered into a single "block" representing a syllable.
Later Developments

Subsequent development of further orthographic elements: word-spacing, punctuation, paragraphing, etc.

Not fixed till early age of print. Reduce ambiguity, make writing increasingly accessible to wider community or in absence of immediate context,
Later Developments

Subsequent development of further orthographic elements: word-spacing, punctuation, paragraphing, etc.

\[
\text{ō̊nòdiko
komqotimē
pateostō
hinnorōpē
siokrēthp
kopuiak:ēda
rēthpion:ē
pē:nomēnē
pytanēon
ēk:ynēkōnē
ēysin}
\]

boustrophedon
Subsequent development of further orthographic elements: word-spacing, punctuation, paragraphing, etc.

It is of a Rome henceforth free that I am to write the history--her civil administration and the conduct of her wars, her annually elected magistrates, the authority of her laws supreme over all her citizens. The tyranny of the last king made this liberty all the more welcome, for such had been the rule of the former kings that they might not undeservedly be counted as founders of parts, at all events, of the city…
I spoke to the boys Sam and Tom.
The press secretary gave them the rules they were not allowed to speak to the committee directly.
To my parents Ayn Rand and God.
The Role of Punctuation

Comrade Stalin. You are right and I was wrong. You are the true heir to Lenin. I should apologize. Trotsky
The Role of Punctuation

Comrade Stalin. You are right and I was wrong? You are the true heir to Lenin? I should apologize?? Trotsky