Finally, the guest editor would like to thank the other contributors for participating in this issue and especially for their patience and willingness to try to communicate to others beyond their own discipline something of the character and importance of what is, in all probability, the oldest writing system of humanity.

Marvin A. Powell
October 1981

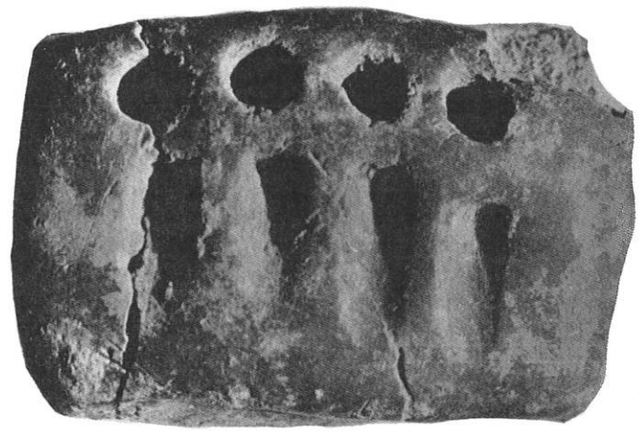
Denise Schmandt-Besserat

From Tokens to Tablets: A Re-evaluation of the So-called "Numerical Tablets"

The paper deals with 185 impressed tablets which illustrate the crucial step between an archaic recording system based upon tokens and writing. The discussion includes the historical background of the discovery of the tablets, their geographic distribution, chronology, and the context in which they were found. The various impressed signs are related to their token prototypes, and a new decipherment is proposed. In the light of the decoding of the most basic types of tokens, the signs are metrological, not numerical as had hitherto been assumed.

The earliest clay tablets bear series of crudely impressed signs (Figure 1). They are usually called "numerical tablets" suggesting that they yield only numerical notations. In this paper I will refer to them as "impressed tablets." I will review the information available on these documents and analyze their relationship to the preceding recording system based on tokens.

Figure 1. Godin Tepe (73-19), impressed tablet, courtesy T. Cuyler Young, Jr., Royal Ontario Museum, Toronto, Canada.



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The Discovery of the Impressed Tablets

The first series of impressed tablets was found on Elamite territory. They were excavated in Susa by Jacques de Morgan in 1901-5. The techniques available at the time did not allow him to distinguish with enough accuracy between the successive levels of occupation, and the impressed tablets found themselves mixed together with later pictographic texts. As a consequence, no special mention was made of them in the first publication of Proto-Elamite tablets published by Vincent Scheil in 1905.[1] When impressed tablets appeared in Mesopotamia in the excavations of Uruk, circumstances were different. Applying stratigraphic techniques and blessed with the discovery of a substantial number of tablets, Julius Jordan was able to follow back in time the major steps of the evolution of writing from the evolved cuneiform script of the third millennium to its first stage in the fourth millennium. His level I of the Eanna precinct brought forth poetic hymns written in cuneiform with the characteristic triangular headed stylus; Levels II and III produced a pictographic script inscribed with a sharp stylus. The signs, which had a phonetic value, were as yet unable to express the syntax of the spoken language. Stratum IV yielded pictographic tablets of a more rudimentary type bearing a sparse number of ideograms preceded by impressed signs indicating quantities. When, in the excavation season of 1930-31, tablets appeared bearing only impressed signs, Jordan was prompt in correctly identifying them as "Vorläufer von pictographischen Tontafeln."[2] The tablets were interpreted as bearing numbers only, and this is why they have since been referred to as "numerical tablets."

Jordan's work was of great importance, since it established the impressed tablets as the first step in the evolution of writing: 1) Signs in impressed technique; 2) incised pictographic signs; 3) shift from ideographic to phonetic value; 4) acquisition of full syntax and use of the triangular headed stylus.

The Background

My previous work has shown that, prior to the tablets, tokens were used for computation and record keeping in the Middle East. The tokens were made of clay and were modeled into various shapes, mostly geometric, including spheres, discs, cones, biconoids, ovoids, cylinders, triangles, sometimes bearing incised and punched markings.[3] The tokens represented a mere elaboration of pebble counting but were a better memory aid, as the distinctive shapes and markings stood for specific economic units such as "one bushel of grain," "one jar of oil," "one pot of beer," or "one fleece of wool." I recently proposed, for instance, to equate the cones and spheres to metrological units of grain and the cylinders and discs as units of animal numeration.[4] The tokens were used in a one-to-one correspondence, and their main function was thus to translate the few commodities of daily life which needed to be recorded/computed into counters easy to handle and store. The fact that each category of goods was computed with tokens of different shapes suggests that there were different numeration systems to count different items. Because the use of abstract numbers is so obvious to us, it will come as a surprise and even as a shock to many to realize that not so long ago number words were tied to concrete groups. This stage is called "objective counting" by mathematicians and its consideration is important for the understanding of this paper. An illustration of objective counting in

present-day language are the many terms we have to express two, such as "a couple of days," "a pair of shoes," "twin brothers," and "a brace of pheasants." In other languages the number names may mean literally "one stone, two stone, three stone" or "one fruit, two fruit, three fruit."[5]

In the fourth millenium, envelopes were invented to hold tokens. These artifacts which appear simultaneously in Mesopotamia, Syria, and Elam at such sites as Uruk, Habuba Kabira, Susa, and Chogha Mish were hollow clay balls the size of a fist. They provided the advantage of keeping together tokens representing special transactions and offered an ideal clay surface to imprint the necessary seals to authenticate them.[6] However, the opacity of clay presented a serious problem, as once the envelopes were closed and the seals applied, the number and types of tokens enclosed were left entirely to memory with no possibility of checking them without breaking the sealings. It was probably to overcome this shortcoming that a technique was developed to make tokens readily visible at all times. The tokens were impressed upon the surface of the envelopes before being enclosed, leaving markings which could be " read." Such markings could be classified into the following types: 1) deep circular, 2) shallow circular, 3) wedge shaped, 4) oval, 5) cylindrical, and 6) triangular. These signs equate tokens in the shape of 1) spheres, 2) discs, 3) cones, 4) ovoids, 5) cylinders, and 6) triangles. It was soon realized that the envelopes filled with tokens and bearing signs could be simplified to lumps of clay bearing signs – these were the impressed tablets.

The Geographic Distribution

Through the years not only did further tablets consistently trickle from among the material recovered at both Uruk[7] and Susa,[8] but they also started to appear in other sites (Figure 2). As so often happens, the findings came in waves. The first ones followed shortly after the Uruk discoveries of the 1930's, and were recovered at Khafaje in 1934/5,[9] Tepe Sialk in 1937,[10] and Tall-i Ghazir in 1948-49.[11] A second series started with the tablet of Mari in 1964[11a] and continued with those of Habuba Kabira,[12] Jebel Aruda,[13] Godin Tepe,[14] and lastly, Chogha Mish in 1974-75.[15] Each of these further discoveries came as a surprise and appeared eccentric, especially those from Tepe Sialk, Godin Tepe, Habuba Kabira, and Jebel Aruda. It had been instinctively presumed that the art of writing had been confined to the main metropolitan centers and had simmered there for an extended time before spreading to more remote regions. Contrary to those expectations, the ten sites which yield impressed tablets are scattered on a radius of one thousand kilometers divided into three present-day countries of the Middle East. Susa, Tepe Sialk, Godin Tepe, Chogha Mish, and Tall-i Ghazir are located in Iran; Uruk and Khafaje in Iraq; Mari, Habuba Kabira and Jebel Aruda in Syria.

The ten sites where the impressed tablets occur share one common denominator: all were located at strategic positions along main arteries of the ancient Middle East. Jebel Aruda, Habuba Kabira, and Uruk were situated on the Euphrates River which constituted the main avenue of communication of the ancient world. There is no doubt that the two Syrian sites upstream served as links to the Syrian hinterland, Anatolia, the Mediterranean, the coastal road to Egypt for the political centers situated downstream such as Uruk. Mari was on the desert road to the Levant. Susa and

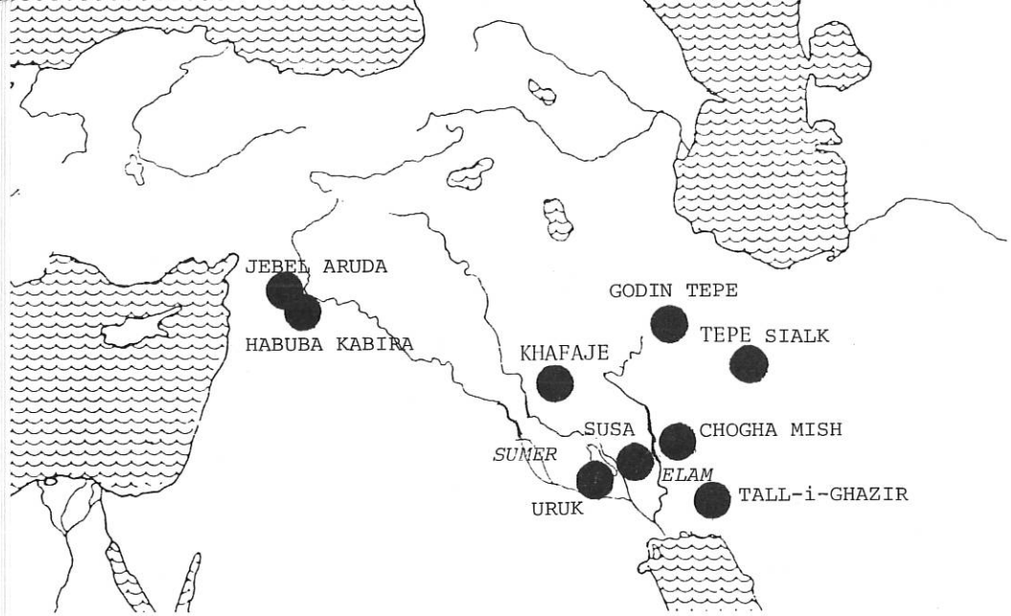


Figure 2. Map showing sites yielding impressed tablets.

Chogha Mish were not only on one main access road to the Gulf, to which they were much closer than today,[16] but also represented the southern gates to the Iranian plateau and the east. Tall-i Ghazir was backed against the southern skirt of the Zagros mountains in the extension of the Ram Hormoz valley, where caravans to Mesopotamia were still assembling in AD 985. The oasis site of Tepe Sialk, sandwiched between the foothills of the Zagros and the Dasht-i-Lut, commanded the unique valley connecting the north of the Iranian plateau with the south. Godin Tepe was in a position to control the Khorasan route and its traffic of lapis lazuli at the passage of the Gamas Ab river. This main route from the east reached Mesopotamia via the Diyala river where Khafaje was situated.

The Description

The tablets constitute a homogeneous group and no distinction can be made between the groups originating in the three various regions of Syria, Mesopotamia, and Elam. The artifacts were apparently considered as purely practical and their manufacture was casual rather than meticulous. No effort, for instance, was made to eliminate the imprint left by the fingers of the scribes while modeling or handling them. Some tablets, particularly from Susa, Uruk, and perhaps especially from Jebel Aruda, are bulky and even crude.

The tablets were made of clay, usually well levigated and only rarely showing coarse inclusions. No stone example is known, and the only alternative to clay yet encountered is plaster, in a group of tablets found by Julius Jordan in the White Temple of Uruk.[17] While these examples required a preliminary burning of the ground limestone, the clay tablets were never fired.

The lack of standardization in the shape of the tablets is indicative of the novelty of the craft. A number of tablets are oval, some roundish, others square or rectangular.

The edges, tapering at first, tend to become flat or slightly concave to provide additional space for notations. The profile of the tablets is also highly variable, and while a majority of specimens have both faces convex, others show one or both faces flat. When one face only is convex, it is generally the obverse.

The tablets are small, with an average size of 5 by 4 cm. and a thickness of 2 cm., and can be comfortably held in the hand.

Nine tablets from Tepe Sialk have the peculiarity of being perforated, which led Ghirshman to believe that they were invoices tied to shipments of goods.[18] Several examples from Godin Tepe have a margin or frame designed probably by pressing the shaft of the stylus along three or four of the sides. In one example an additional line divides the face into two horizontal cases, thus separating signs of two different orders.[19]

Most tablets bear designs imprinted by cylinder seals rolled over the signs. The sealings were used to authenticate the documents and suggest an official use.

The Number of Tablets

The total number of impressed tablets – complete or fragmentary – included in the present study amounts to 186. The majority originate from Iran with a total of 150 specimens, including 90 from Susa, 42 from Godin Tepe, 13 from Tepe Sialk, 5 from Chogha Mish, and 1 from Tall-i Ghazir. The tablets from Susa have been recovered in successive excavation campaigns by Jacques de Morgan in 1901-11 and by Roland de Mecquenem in 1912-46. The recent expeditions by Jean Perrot added 11 specimens in 1969-71, 6 in 1972, and most recently, 11 in 1977.

The number of known Iraqi examples amounts to 18. This may be deceptive as the 17 examples reported for Uruk seem to represent only a fraction of the actual material recovered.[7] The third report acknowledges a series of "several" impressed tablets recovered during the season of 1930-31, of which only two are published. Two further specimens are discussed in the IVth report, three in the Vth, five in the VIIIth; and finally a single example in each of the XIXth, XXth, XXIIIrd, XXIVth, and XXVth seasons. To these 16 examples from Uruk there can only be added, in Iraq, the single specimen found in Khafaje. There are 15 impressed tablets from Syria, with 10 originating from Habuba Kabira, five from Jebel Aruda, and one from Mari.

It is interesting to note that the antiquity market, which since the late 19th century has brought forth a number of pictographic tablets, has not yet produced any impressed tablets and that all specimens come from controlled excavations.

The Context

The tablets are found in a variety of settings including temples, administrative buildings, or domestic structures, some of which have been associated by archaeologists with mercantile activities. At Uruk and Khafaje the tablets belonged to sacred precincts. Seven of the Uruk tablets came from the White Temple. Two of them were found associated with an alabaster theriomorphic vessel carved in the shape of a dove. The 11 remaining examples belonged to Eanna where they were found mixed into the destruction debris of level IVa. The deep sounding of Khafaje in which the tablet was unearthed was dug below the Early Dynastic complex of the Oval Temple, an area which might already have been sacred in the early periods.

All the tablets from Susa come from the mound of the acropolis. The building in which the most recent group was excavated appears to be of domestic character. Some tablets were resting upon the floor while others were kept in pottery vessels. In one case two specimens were found in a coarse bowl together with an envelope filled with tokens.[20] The tablets of Tepe Sialk and Tall-i Ghazir were in the context of simple mud-brick houses. At Habuba Kabira envelopes, tokens, and tablets were in the main room of a spacious building interpreted as the house of a merchant.[21] The situation is not so clear at Chogha Mish, where the tablets were found in refuse pits.

At Godin Tepe and Jebel Aruda the tablets belonged to imposing buildings probably used for official functions. At Jebel Aruda they were associated with cylinder seals, torn jar sealings, and a few sherds.

Chronology

The chronology of the impressed tablets is best illustrated at Susa.[22] The earliest examples appear in level 18 in association with envelopes and tokens; they continue in level 17 when envelopes disappear; in level 16 they are replaced by tablets bearing incised proto-Elamite pictographic signs.

The tablets, consequently, can be divided into three closely consecutive groups dated between 3200 and 3000 BC. The earliest group includes the specimens from Susa 18 and Chogha Mish, the Red Temple of Uruk, and Habuba Kabira. The tablets of Uruk belong to stratum IVa. The assemblages of the three other sites share with Uruk IVa a number of typical features which suggest their contemporaneity. The parallels include tokens, envelopes, seals, bevelled-rim bowls, and four-lugged jars.

The second group consists of the tablets from Susa 17, the White Temple of Uruk III, those from Jebel Aruda, and Khafaje. The characteristic changes in the assemblages include the disappearance of complex tokens and envelopes, a linear style of glyptics, and theriomorphic alabaster vessels.

The third group consists of the tablets of Susa 16, Tepe Sialk, and Tall-i Ghazir. The assemblages of these sites are characterized by high bevelled rim bowls (so called *"Blumentopf"* vases), proto-Elamite sealings, and lugged jars with rope appliqué bands. The assemblage of Godin Tepe V, which includes the jars with rope appliqué bands but no high bevelled rim bowls, may be viewed as a transition between the second and third group.

The Origin

Several studies have been devoted to the fact that Uruk IVa in Mesopotamia, Habuba Kabira in Syria, Susa 18 and Chogha Mish in Iran share a common assemblage.[23] It has been pointed out that the shared items in question – tokens, envelopes, tablets, seals, sealings, four lugged jars, and bevelled rim bowls – all have an exclusively economic function.[24] It is undisputed that the pottery is at home in Mesopotamia and foreign in Elam and Syria. Scholars have explained the phenomenon by the presence of Sumerian "'colonial installations" in foreign countries. Amiet[25] and Strommenger[26] suggest merchants; Beale[27] proposed outposts for the control of trade routes. Whatever it may be, the tablets appear as an homogeneous group of artefacts shared by a community of people relying upon the Mesopotamian recording system at the time when tokens were being replaced by tablets. It would therefore be a mistake to

separate the impressed tablets into three categories according to their find spots. This would erroneously suggest a triple invention of writing simultaneously supplanting the tokens. The same conclusion had been reached by epigraphists, such as A. A. Vaiman who considers the proto-Elamite system of notations as a mere variant of the proto-Sumerian system.[28]

It is important to note that the impressed tablets represent only a very short episode in Uruk while they lasted for about one century in Syria and Elam. Pictographic tablets started to supplant the impressed tablets within the same stratum of Uruk IVa but the new Sumerian writing technique never seemed to reach Syria or Elam. This may well suggest that the active Sumerian outward involvement lasted only during a brief period close to 3100 BC.

The second group of tablets was contemporary with those of Jemdet Nasr, showing that occasionally impressed tablets continued to be used at Uruk, parallel with the more elaborate script. The continued absence of pictographic tablets in Syria and Elam demonstrates that the development of writing there was out of step with Mesopotamia and remained at a complete stand-still.

All the tablets of the third group come from Iran, showing that the impressed technique lingered longest in that region. The use of writing appears to have been discontinued in Syria while Elam, finally, built upon the Sumerian impetus to develop its own writing system. At Godin Tepe and Tepe Sialk the last impressed tablets are found associated with the first proto-Elamite pictographic tablets, which soon superseded them.

The Signs

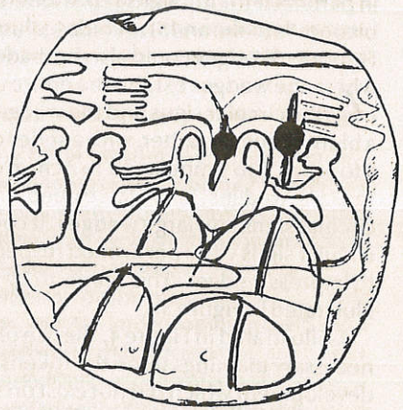
Nineteen signs can be identified on the impressed tablets. They are divided into the following categories: 1) *Deep circular:* a. small, b. large, c. incised, d. punched, e. appendix, f. & g. fractions; 2) *Shallow circular;* 3) *Wedge shaped;* a. small, b. large, c. punched, d. sideways, e. apex to apex; 4) *Biconoid;* 5) *Oval;* 6) *Cylindrical;* 7) *Triangular:* a. plain, b. incised. (See also Figure 5). A number of signs were made by impressing the tokens themselves into the clay of the tablets, and this seems the case in particular for the signs representing spheres with appendix (Figure 5, column 5), biconoids (column 15), ovoids (column 16), and triangles (columns 18 & 19 and Figure 4). Wedges could also be made by impressing a cone as illustrated in Figure 3 where the wedges exhibit the entire outline of the cone used to impress them. However, the circular signs and the wedges seem, as a rule, to have been impressed with a blunt stylus, or rather, with a series of at least three styluses measuring alternatively 3 to 5 mm, 7 to 9 mm, and 1 to 2 cm in diameter to make 1) the small circular signs and the long wedges, 2) the large deep circular signs and short wedges, and 3) the shallow circular signs and large wedges. It could also be posited that the deep and shallow circular signs were performed respectively with the tip and the base of cones used to impress wedges. This seems to be the case, for instance, in the tablet from Susa illustrated in Figure 3.

As illustrated in Figure 4, the use of a pointed stylus was introduced to add all necessary markings upon the tokens' impressions. This represents an interesting development which did not exist on the envelopes, where incised tokens appeared as reverse images with ridges featuring incised markings.

Figure 3. Susa (Sb 2313) impressed tablet, courtesy Musée du Louvre, Département des Antiquités Orientales, Paris, France.

Figure 4a. Susa (Sb 1975 bis) tablet with two incised circular and four triangular markings. Courtesy, Musée du Louvre, Département des Antiquités Orientales, Paris, France.

Figure 4b. Susa (Sb 1975 bis), after Roland de Mecquenem and Georges Contenau, Aarchéologie Susienne, *Mémoires de la Mission Archéologigue en Iran* 29 (1943) fig. 17: 2 (drawn by Ellen Simmons).



On the majority of the tablets the signs are organized in horizontal rows traced parallel to the larger side of the tablets (Figures 1, 4, 7, 8). The lines are spaced evenly upon the face, starting from the top. Following the sense of symmetry which so strongly governs Sumerian and Proto-Elamite art, the signs are placed in the center of the line rather than along a side margin.

Signs of different types are usually not mixed on the same line, and each line is therefore composed of series of identical signs repeated to the required multiplicity (Figures 1, 4, 7, 8). Contrary to this norm, the tablet shown in Figure 3 exhibits two different types of signs associated on the same line. The signs are by no means placed at random but follow a logical order. The units expressing the largest quantities appear on the top line and they are followed by lines of units representing lesser quantities in hierarchical order. Because each line usually consisted of series of identical signs, they could be written or read in any direction without altering the content. The rare tablets bearing signs of different values on the same line indicate, however, that writing and reading must usually have been performed from right to left, because the signs standing for the larger quantities are placed on the right. This is the case of the tablet from Susa illustrated in Figure 3 and the tablet from Khafaje. Two interesting tablets from Godin Tepe illustrate a case in which a scribe could not accommodate nine identical signs on a single line.[29] A first line was started from right to left, then a second line continued from left to right to enter the remaining few units. A unique tablet from Habuba Kabira (MII: 127) bears long wedges along two perpendicular edges. These details stress that writing, at this stage, had barely emerged from the abacus system which preceded it. The repetition of signs carried on the old habit of lining up tokens to match a required quantity. The impressed tablets, one may say, were still read in exactly the same manner as an abacus is handled, by mentally computing each line before adding the smaller units of the following row.

Most tablets are written on one side only, but some examples bear additional notations on the second side or along the edges. Some tablets were turned for reading on an horizontal axis, while others were handled like the page of a book. Each face seems to present a separate account, and in no circumstances do the number of signs on the second face add up to a total summarizing the computation of the obverse, as is usually the case in pictographic tablets. The shape of the tablet does not seem to be indicative of the type of accounts it bears.

The Place of the Impressed Tablets in the Evolution of Recording/Writing

The impressed tablets represent the third step in the evolution of recording in the Middle East. This evolution can be summarized as follows: 1) tokens (three-dimensional symbols), 2) envelopes bearing signs (tokens supplemented by two-dimensional impressed signs), 3) impressed tablets (two-dimensional impressed signs), and 4) pictography (incised signs). The link between the token prototypes and the resultant impressed signs are close and often very obvious. There are signs, as were described above, which can be pointed out as being the mere imprint of a token. The tablet shown in Figure 4 illustrates one of these instances and illustrates triangular signs which could only be made by impressing a token in the shape of a triangle in the moist clay – not by stylus. The three large wedges in Figure 3 show the complete outline of the cone used to impress them.

Likewise, a strong similarity exists between the impressed signs on tablets and those found on the surface of the envelopes. All the signs impressed on the envelopes (deep circles, shallow circles, short wedges, long wedges, ovals and triangles) are unchanged in the repertory of the signs on tablets.

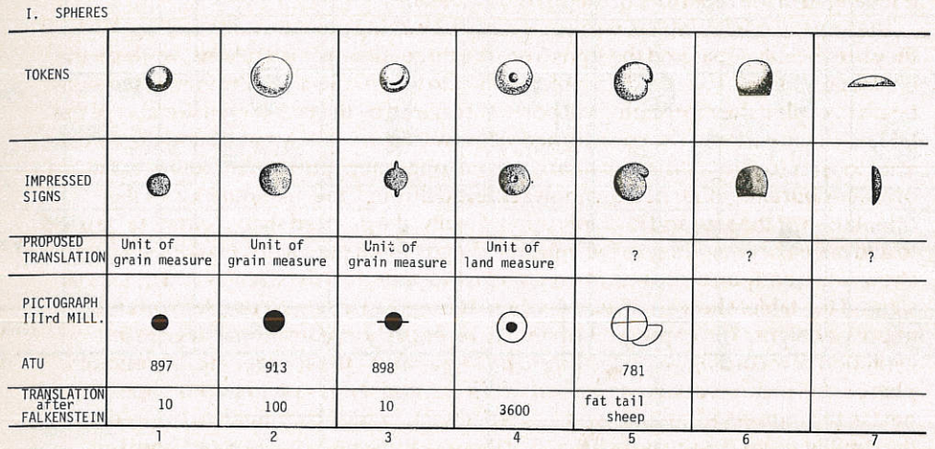
The impressed clay tablets represent a crucial turning point towards writing. First they irrevocably separated the signs from the three-dimensional tokens, while on the envelopes the signs were still complementary to tokens. Second, the impressed signs begin to exploit the morphological potential offered by the two-dimensionality of the tablets' plane surface. The cone turned sideways (Figure 5, column 13) and the cones apex to apex (column 14), for instance, are no longer straight-forward representations of tokens but altogether new symbols achieved through the manipulation of the orientation of the sign and its duplication. Finally, the pointed stylus started to be used to add necessary markings to the impressed signs when the tokens markings did not show sufficiently on their impression. This is illustrated on the circular and triangular signs of the tablet shown in Figure 4, where the median incision complements the impressed signs. The impressed tablets represent a short transitional stage in the evolution of recording, soon leading to pictography. In the succeeding, pictographic phase small pictures of tokens incised with a pointed stylus – pictographs – appear next to the impressed circular wedge-shaped signs, which continued to be used in the third millennium. This new technique of incising the symbols originated from the practice of tracing markings upon the impressed signs, as described above. The incised signs were more accurate and legible, but more importantly, pictography brought about the realization that any concept could be communicated by a sign. This meant a sudden proliferation of symbols: wild animals and parts of the human body, which never had a token in the previous system of recording, were represented by a small incised sketch; adjectives such as "furious" were communicated by the suggestive drawing of a man's head with his hair raised; verbs such as "to eat" were expressed by combining the two signs for a human head and bread; and, finally, personal names were rendered by using phonetic value of the concepts, in a rebus principle. Pictography, therefore, brought recording to new thresholds: first, it opened the system to all fields of human endeavour; second, the signs henceforth started to model themselves into representation of language.

Pictography may also prove to be an essential step towards the acquisition of abstract numbers. The appearance of pictographs representing ears of wheat and barley placed next to the units for grain attest that, henceforth, the quantity of all grains were represented by the same wedges and circles while the quality was specified by adjoining pictographs. Furthermore, the combination of wedges and circles with adjoining pictographs indicating all possible commodities, suggest that these signs took the value of abstract numbers, finally breaking down the archaic system of special numerations for various categories of items.

The Meaning of the Signs

The key to understanding the impressed signs and their token prototypes lies in the cuneiform writing system of the third millennium. It has proven possible for epigraphists to identify the meaning of some pictographs by tracing back the evolution of cuneiform signs to their original pictographic form. Jordan and Scheil

Figure 5. Chart of impressed signs and corresponding tokens and pictographs (drawn by Ellen Simmons).



Column 1
Token prototype: sphere
Impressed sign: deep circular sign about 0.3 to 0.5 cm in diameter, sunk between 0.5 and 1.0 cm into the clay
Pictograph: ATU 897
Translations: Falkenstein: number, 10. Vaiman: measure of capacity, 10. Friberg: unit of grain metrology, 1 bariga.

Column 2
Token prototype: large sphere
Impressed sign: deep circular sign, about 0.7 to 0.9 cm in diameter, sunk between 0.50 and 1 cm into the clay
Pictograph: ATU 913
Translations: Falkenstein: number, 100. Vaiman: measure of capacity, 100. Friberg: unit of grain metrology, 10 bariga.

Column 3
Token prototype: sphere with a deep incised notch
Impressed sign: deep circular sign with a median incision
Pictograph: ATU 898
Translations: Falkenstein: Number, 10. Vaiman: Unit of measurement, 10. Friberg: Unit of land measure, $^1/_8$ iku.

Column 4
Token prototype: punched sphere
Impressed sign: circular sign with a central punch mark
Pictograph: after M. W. Green
Translations: Green: number, 3600. Friberg: unit of land measure, 10 bur.

Column 5
Token prototype: pinched sphere
Impressed sign: circular sign with an appendix
Pictograph: ATU 781 shares the same outline; however, it has an additional incised cross
Translation: Falkenstein: fat tail sheep

Column 6
Token prototype: $^3/_4$ sphere
Impressed sign: $^3/_4$ circle
Pictograph: ATU 915
Translation: none

Column 7
Token prototype: $^1/_4$ sphere
Impressed sign: $^1/_4$ circle
Pictograph: ?
Translation: none

	II. DISCS		III. CONES				
TOKENS							
IMPRESSED SIGNS							
PROPOSED TRANSLATION	Unit of grain measure	10 animals	Unit of grain measure	Unit of grain measure	Unit of land measure	Unit of land measure	Unit of grain measure
PICTOGRAPH IIIrd MILL.							
ATU	907	753	892	899	905		
TRANSLATION after FALKENSTEIN	3600	slab, total, circle	1	60	600		fraction
	8	9	10	11	12	13	14

Column 8
Token prototype: disk with straight edges
Impressed sign: shallow circular sign, ca. 2 cm. in diameter
Pictograph: ATU 907
Translations: Falkenstein: number, 100 or 3600. Vaiman: measure of capacity, 100. Friberg: unit of grain metrology, 10 bariga.

Column 9
Token prototype: disk with tapering edges
Impressed sign: circular sign
Pictograph: ATU 753 (?)
Translations: Falkenstein: slab, block, total, circle. Vaiman, Friberg: unit of animal numeration, 10.

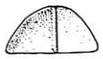
Column 10
Token prototype: cone
Impressed sign: short wedge
Pictograph: ATU 892
Translations: Falkenstein: number, 1. Vaiman: unit of capacity, 1. Friberg: unit of grain metrology, 1 ban.

Column 11
Token prototype: large cone
Impressed sign: large wedge
Pictograph: ATU 899
Translations: Falkenstein: number, 60. Vaiman: unit of capacity, 300. Friberg: unit of grain metrology, 180 ban.

Column 12
Token prototype: punched cone
Impressed sign: wedge with a punch mark
Pictograph: ATU 905
Translations: Falkenstein: number, 600. Vaiman: unit of capacity, 1000. Friberg: unit of land measure, 1 eše.

Column 13
Token prototype: cone
Impressed sign: Horizontal wedge
Pictograph: ATU 892
Translation: Friberg: unit of land measure, 1 iku.

Column 14
Token prototype: cone
Impressed sign: two horizontal wedges apex to apex
Pictograph: after Vaiman
Translation: Vaiman: unit of measurement, 120

	V. BICONOIDS	VI. OVOIDS	VII. CYLINDERS	IX. TRIANGLES	
TOKENS					
IMPRESSED SIGNS					
PROPOSED TRANSLATION	?	?	1 Animal	Unit of grain measure	Unit of grain measure
PICTOGRAPH IIIrd MILL.					
ATU	428	733			900
TRANSLATION AFTER FALKENSTEIN	Good/Sweet	Oil		Fraction	60
	15	16	17	18	19

Column 15
Token prototype: biconoid
Impressed sign: diamond
Pictograph: ATU 428
Translation: Falkenstein: good, sweet.

Column 16
Token prototype: ovoid
Impressed sign: oval
Pictograph: ATU 732, shares the same outline. ATU 733 has an additional incised line at the maximum width.
Translation: Falkenstein: ATU 732, nail; ATU 733, oil

Column 17
Token prototype: cylinder
Impressed sign: long wedge
Pictograph: after Friberg
Translation: Vaiman, Friberg: unit of animal numeration, 1

Column 18
Token prototype: triangle
Impressed sign: triangle
Pictograph: after Vaiman
Translations: Vaiman: unit of capacity, $^1/_5$.
Friberg: unit of grain metrology, $^1/_5$ *ban*.

Column 19
Token prototype: triangle with a median incision
Impressed sign: triangle with an incised median line
Pictograph: ATU 900
Translations: Falkenstein: number, 60. Vaiman: unit of measurement, 1.

correctly assumed that the translations of the pictographs could, in turn, be applied to decipher the corresponding signs on the impressed tablets. The same method is applied here to decode the impressed signs as well as their token prototypes. Three stages of the evolution of the impressed signs are presented in the following section (Figure 5): 1) a token prototype, 2) the corresponding impressed sign, and 3) the following pictographic sign. The pictographs are drawn from the list compiled by Adam Falkenstein[30] with the exception of four identified by Green (columns 4, 14), Friberg (column 17), and Vaiman (column 18). The translations presented for each sign are those proposed by Falkenstein, Green,[31] Vaiman,[32] and Friberg.[33] A discussion will follow based upon my research on tokens at large and on a particular series of 26 envelopes with their content of 281 tokens.[34] It is important to emphasize that all of the translations, as well as the alternative interpretations proposed by me in this paper, must be regarded strictly as working hypotheses.

I. Units of Grain Metrology

Column 1. I view the token prototype of the circular sign ATU 897 as a small sphere, based upon the fact that small spheres contained in envelopes are frequently represented on the surface of these envelopes by a corresponding number of small deep circular markings.

Columns 2, 8. Falkenstein identified two circular impressed signs, ATU 913 and 907, which may correspond to the two categories of signs which I differentiate as "deep" and "shallow." There are, namely, a number of tablets where the small deep circular signs (column 1) are associated with larger deep circular signs (column 2), while on others they are together with large shallow circular signs (column 8) (Figure 3). The deep and shallow signs appear to be different entities and may correspond respectively to large spheres and disks.

There are spheres of two different sizes (large and small) among the tokens found at large as well as among those found enclosed in envelopes. The envelope Sb 1967 from Susa, for instance, yielded a total of 15 tokens including four small and two large spheres;[35] another specimen from Chogha Mish contained eight tokens including one small and one large sphere.[36] One would expect that the large sphere (column 2) would be represented by the same deep circular marking used for the small spheres, only larger in diameter. This fact, unfortunately, cannot be verified on the envelopes because none of those yielding large spheres bore any markings. Tablets such as MII 130 from Habuba Kabira, which bears five large deep circular signs followed by five small deep circular signs,[37] seem to illustrate, however, the existence of two different deep circular signs which logically could correspond to the small and large spheres.

Two types of disks are consistently represented among the tokens found at large: 1) with straight sides (column 8); 2) with tapering sides (column 9). It seems apparent that these shapes were made deliberately and that each form stood for a different commodity. Both types are found enclosed in envelopes, and it can be expected that they were represented by closely similar circular signs on the tablets.[38] Disks with tapering edges were found enclosed in two envelopes from Susa, Sb 1927[39] and Sb 1940,[40] which bore on their surface a corresponding number of shallow circular markings. Unfortunately, none of the envelopes containing

disks with straight edges bear markings, and therefore no comparison is yet possible between the symbols representing the two types of disks.

Although the envelopes contained accounts of mixed goods and therefore could house any possible combination of tokens, it appears not to be fortuitous that in the four instances when disks with straight edges were found included in an envelope, they were associated with small spheres[41] and in one case with small and large spheres.[42] On the contrary, the five envelopes which contained disks with tapering edges did not yield spheres. The association of spheres and disks with straight edges seems to be reflected in the frequent association of deep and shallow circular signs on the impressed tablets. I would like, therefore, to propose the possibility that ATU 897, 913, and 907 may, in fact, represent a sequence corresponding to three tokens: 1) the small sphere, 2) the large sphere, and 3) the disk with straight edges. The fact that both the large sphere and the disk with straight edges were enclosed in same envelope demonstrates that the two symbols were separate entities. The identification of two circular signs with "deep" and "shallow" signs will have to be verified by epigraphy and has presently to remain hypothetical. The discussion of the disks with tapering edges will be resumed later in the paper.

Columns 10, 11. The cones, like the spheres, are found in two different sizes; I view them as the prototypes of the short wedges ATU 892 and 899.

Columns 10, 1, 11, 2, 8. Falkenstein identified these signs as the sequence of abstract numbers 1, 10, 60, 100, and 3600 used in the Sumerian protosexagesimal counting system. In agreement with Falkenstein, Jordan and Scheil also gave numerical values to the corresponding signs on the impressed tablets. Jordan thought that the quantities entered referred to goods that were obvious to all parties involved.[43] Scheil, on the contrary, believed that numbers could only refer to people "on n'aurait pas omis ou sous entendu le nom d'objets quels qu'ils fussent."[44] Consequently, the tablet in Figure 1 would have been interpreted by Scheil as: "Quantités d'hommes" (Scheil usually avoided specifying the numbers involved). According to Jordan the same tablet would have read: $(10 \times 4) + (1 \times 4) = 44$ (of a commodity known to the recipient). In recent years the Soviet scholar A. A. Vaiman has departed from Falkenstein's translations of the impressed signs as abstract numbers, proposing instead that they represent metrological units. Each of the symbols, he writes, "expresses at the same time the number 'one' and the term for a specific measure."[45]

Following Vaiman's publications, Jöran Friberg of the University of Göteborg used a mathematical approach to further specify the value of several signs as metrological units of grain (Figure 6).[46] According to these latest developments, the tablet discussed above means the following: 4 bariga and 4 ban of grain (equivalent to 168 liters–about 5 bushels).

These new results coincide with my own findings concerning the value of the signs' token predecessors. The analysis of groups of tokens found in the clay envelopes led me to conclude that the tokens were used in a one-to-one correspondence. None, therefore, assumed the value of an abstract number, but each token represented an economic or metrological unit of a specific commodity which was repeated as many times as necessary to express the quanity involved.[47] It should be emphasized here that the proposed translations borrowing the third

millennium nomenclature of "ban" and "bariga" is not fully adequate. In fact the tokens and their sign counterparts probably represented informal containers such as "a peck" and "a bushel" in which the goods were usually handled and were by no means multiples of one another. This seems to be demonstrated, in particular, by the fact that seven tablets bear series of six to eight short wedges,[48] instead of using the larger unit "bariga" standing in historical times for 6 ban. As a consequence, it will be more realistic to interpret the fragment of tablet in Figure 3 which shows three large wedges, 1 shallow circular sign, and four (visible) deep circular signs: three "large," one "medium," and four "small" measures of grain.

It is conceivable that there was a greater gamut of grain metrological units during the archaic period, compared to historical times. This could account for the fact that some units such as the large sphere (or the disk) fell into disuse when standardization made them superfluous.

Column 3. Series of spherical tokens bearing a deep incised notch may correspond to the deep circular signs with a median incised line (Figures 4 and 4a). Vaiman views barred signs as representing varieties of cereals and a single line, in particular, as standing for wheat.[49] As a consequence, the two deep circular signs with an additional incision on the tablet in Figures 4 and 4a may be interpreted as 2 bariga of wheat.

Columns 18-19. Vaiman presents a series of signs of triangular shape, plain, with a median incised line (column 19) and with sets of multiple lines in various combinations. He proposes a plain triangular sign as a metrological unit of capacity standing for $\frac{1}{5}$.[50] Friberg, in turn suggests a plain triangular sign as a metrological unit of grain standing for $\frac{1}{5}$ ban (Figure 6).[51] As a consequence, the two top lines of the tablet shown in Figure 7 may be read: 5 ban and $\frac{2}{5}$ of grain.

Following Vaiman's interpretation of barred signs, the triangle with a median incised line may correspond to a measure of wheat. If this assumption is correct, the tablet in Figure 4 can be interpreted as 2 bariga and $\frac{4}{5}$ ban of wheat. It still remains to be explained why the triangular signs with a median incision do not have the same orientations as the plain ones.

Column 14. Here the cone prototype is doubled to form a new sign featuring two wedges apex to apex (Figure 7). This illustrates the first use of graphic design to create new symbols and represents an important departure for writing. The sign can be paralleled to a unit of capacity identified by Vaiman as $\frac{1}{10}$.[52] Thus for the tablet of Figure 7 one may tentatively propose the interpretation "5 $\frac{2}{5}$ and $\frac{1}{10}$ ban of grain."

II. Units of Land Measure

Columns 13, 12,1, 4. These signs and their matching token prototypes may possibly correspond to the sequence of signs designating area measures (Figure 6).[53] There may be a possible relationship between these signs and those for grain metrology which might be related to the calculation of area measures in terms of seed ratios. The unit of land measure corresponding to 1 iku is differentiated from the unit of grain metrology for 1 ban by turning the wedge sideways thus taking advantage of graphic design. The option of changing the orientation of the sign, of course, did not exist for the circular sign, which remains the same. Multiples of the iku and the bur would seem to be indicated by a punch mark.

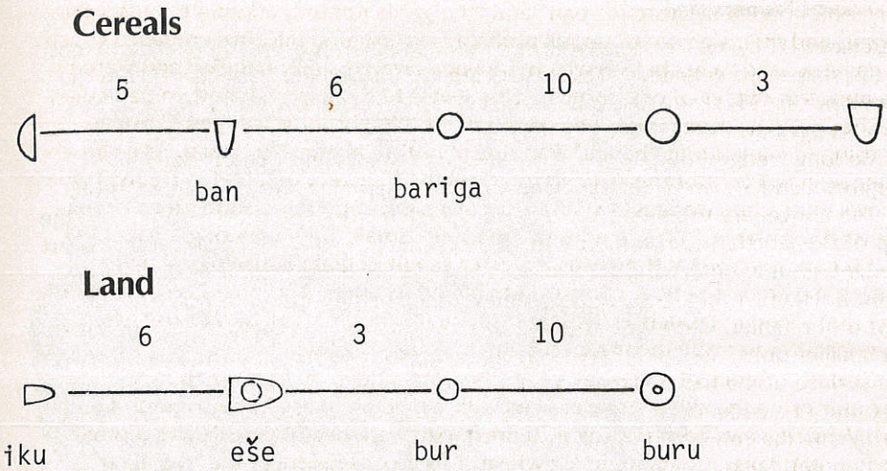


Figure 6. Sumerian and Proto-Elamite numeration systems after Jöran Friberg, *The Third Millenium Roots of Babylonian Mathematics, I.A Method for the Decipherment through Mathematical and Metrological Analysis of Proto-Sumerian and Proto-Elamite Semi-Pictographic Inscriptions.* Chalmers University of Technology and the University of Göteborg, Department of Mathematics (1978-9) p. 10, 20, 46.

Figure 7. Godin Tepe (73-291), impressed tablet, courtesy T. Cuyler Young, Jr., Royal Ontario Museum, Toronto, Canada.

III. Animal Numeration

Column 17. I view the long wedges as the graphic representation of the tokens in the shape of a cylinder.[54] This assumption is supported by the fact that in the envelope Sb 1940 from Susa the three cylinders enclosed correspond to three long wedges on the surface.[55]

The long wedges are placed, as a rule, along the lower edge of the tablet (Figures 8 and 9), which may provide a clue to their meaning. The signs, as discussed above, are usually organized in lines of decreasing order starting from the top of the tablet. The two tablets in Figures 1 and 7 show, for instance, that short wedges assume different positions according to the signs they are associated with. In Figure 1 the short wedges follow circular signs and occupy the lower part of the tablet, while in Figure 7 they are placed on the top line to allow place for smaller units. The systematic placing of the long wedges on the lowest possible surface of the tablet seems to point out that they represent the lowest, indivisible unit of a sequence. Following this reasoning, I propose to view the long wedges as the smallest, indivisible unit of a numeration system for animals (or people). Such a sequence, which could not accommodate any fractions, is suggested by Vaiman (and after him by Friberg) to start with a wedge standing for 1.[56] As a consequence, I propose to read the eight long wedges shown on the tablet in Figure 8 as "8 animals" and the nine (visible) wedges of Figure 9 as "9 animals." The special numeration for animals includes further multiples and, in particular, a circular sign standing for 10, as will be discussed below.

Column 9. Groups of three disks with tapering edges were found enclosed in two envelopes from Susa SB 1927[57] and Sb 1940[58] and were represented on their surface by groups of three corresponding shallow circular markings. It is therefore to be expected that circular signs representing disks with tapering edges were transposed onto the impressed tablets.

As for the meaning of these tokens, there is an interesting series of disks which may be helpful for their identification. The disks are often, although not always, characterized by a strongly convex face and slanting edges, and they bear distinctive patterns of incised lines. These tokens can be matched to pictographs featuring an incised circle filled with identical patterns of incised lines which are translated as "sheep, ewe, lamb, wool, cloth, and garment."[59] I find it striking that commodities of closely related meaning—such as small animals of various breeds, sexes, and ages and their products used in the weavers' craft — are all represented by a disk bearing various markings. I would anticipate the plain circle to represent the root of the series and to be a common unit of animal numeration. The pictograph ATU 753 which features a circle and could logically represent the plain disk is, however, presently translated "slab block, total, circle" which does not seem to correspond. There is, however, a circular unit of animal numeration proposed by Vaiman[60] to stand for 10 animals which may provide the answer. This interpretation finds support in the fact that, among the five envelopes which yield disks with tapering edges, three also included cylinders.[61] The envelope Sb 1940 from Susa discussed above, which contained three such disks and three cylinders corresponding on the surface to three circular markings and three long wedges, would suggest a total account of 33 animals.

Figure 8. Susa (Sb 6299), impressed tablet, courtesy Musée du Louvre, Département des Antiquités Orientales, Paris, France.

Figure 9. Susa (Sb 6299), impressed tablet, courtesy Musée du Louvre, Département des Antiquités Orientales, Paris, France.

It seems evident that the envelopes, which sometimes yield as many as five types of tokens, could hold accounts of mixed goods. The impressed tablets, on the contrary, appear to be dealing mostly with accounts of a single commodity. In this light, the circular sign on the tablet in Figure 8 could be viewed as standing for 10 animals because it is associated with long wedges. It is a deep circular sign, not a large shallow marking as those impressed on the envelopes yielding disks with tapering edges. It may be that a circle associated with long wedges immediately conferred the notion of a flock of 10 animals and that it was unnecessary to the scribe to make that circle in a very particular way. It was, of course, easiest to impress the circular sign with the same stylus as that used for the long wedges and therefore producing a small circle.

The Meaning of the Remaining Signs

The deep circular markings standing for the spheres and the short wedges standing for cones are by far the most frequently used signs. They occur respectively on 88 and 69 tablets. If, therefore, the interpretation of these two signs proposed above should prove to be correct, we would have identified the objects and the numerical relationships of 85% of the impressed tablets. The long wedges standing for cylinders and the shallow circles standing for disks are next in frequency and appear on 30 and 15 tablets respectively, the remaining signs are rare. The irregular circle shown on two tablets from Susa[62] is similar to the later sign for "fat tail sheep." The ¾ circle shown on a tablet from Susa[63] and the ¼ circle of a tablet from Godin Tepe[64] still await identification. The biconoid which appears on one tablet from Godin Tepe[65] can be paralleled with the corresponding token identified as "sweet." The oval sign which occurs on one tablet from Chogha Mish,[66] one tablet from Jebel Aruda[67] and one tablet from Habuba Kabira[68] may tentatively be compared with the ovoid token standing for "oil."

The Function of the Tablets

The "translation" of the various signs proposed above assumes that the tablets were accounts dealing with foodstuffs and, in particular, with grains and animals. The amounts of goods recorded were strikingly small: the quantities of grain usually vary between five ban and four bariga and rarely exceed 12 bariga. The number of animals usually range between one and ten. These small quantities make it unlikely that the tablets pertained to long distance trade of costly material as has been suggested. One would expect that shipments of lapis lazuli, metal, or other precious goods would entail the exchange of similarly valuable materials rather than small quantities of staples. The texts are similar in form and context to the later administrative tablets dealing with 1) receipts of offerings brought to the temple, 2) distribution of rations to workers and dependents of the temple, 3) release of seeds for planting the fields.

Conclusion: Writing or Pre-writing?

The impressed signs were mere accountant notations. Should they be considered as writing or pre-writing? The answer depends upon the definition of writing adopted. Some scholars place the dividing line between pre-writing systems and writing when the signs take a *phonetic* value, others at the emergence of *graphic* symbols.

According to the former definition, the impressed signs do not qualify as writing as they were ideographs and entirely unrelated to phonetics. According to the latter, the impressed signs both on envelopes and impressed tablets are writing because they are a communication system by means of conventional markings. The most appropriate term for the impressed tablets may be "proto-writing" thus emphasizing their transitional character. The impressed signs completed the shift from three-dimensional tokens to their graphic representation and thereby represent the most extraordinary and significant event in the evolution of recording.

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Abbreviations

ATU: Adam Falkenstein, *Archaische Texte aus Uruk*. ("Ausgrabungen der deutschen Forschungsgemeinschaft in Uruk-Warka," Bd. 2.) Berlin: Kommissions-Verlag Harrossowitz (1936)
DAFI: Délégation Archeólogique Française en Iran
MDP: Mémoires de la Mission Archéologique Française en Perse
OIC: Oriental Institute Communications. The Oriental Institute of the University of Chicago
UVB: Uruk, Vorläufige Berichte, Abhandlungen der preussischen Akademie der Wissenschaften, philosophisch-historische Klasse, Berlin

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M. W. Green

The Construction and Implementation of the Cuneiform Writing System

Cuneiform was, from its inception, not merely a collection of individual symbols, but a coherent system of information manipulation for which written characters were the main, but not the only, component. This system did not evolve by itself, but was manufactured, developed, and implemented within the framework of a bureaucratic organization which controlled the distribution not only of goods and services but also of status and information. That institution produced the demand for a control technology for which the cuneiform writing system was the eventual realization. While the user institution imposed specific, characteristic constraints and demands, it also adjusted its own needs and goals to adapt to restrictions and functions of the technology itself. We look at the early development of the cuneiform writing system with special attention to the less well recognized peripheral components and to interactions between the technology and its user.

I Introduction

1 The Archaic Cuneiform Script

This article focuses on the early "archaic" stages of the cuneiform writing system. According to the archaeologically-based chronology of Mesopotamia, this refers to the Late Uruk and Jemdet Nasr periods (ca. 3300-2900 BC) and corresponds to archaeological levels IV (Late Uruk) and III (Jemdet Nasr) at the site Uruk and to the single-period type-site Jemdet Nasr. The archaic tablets discovered at these two sites form the basis for our discussion—especially the Uruk tablets which we have been studying intensively for the past several years.[1]

The dating of the archaic cuneiform script has never been rigorously based on archaeological level because most of the tablets from Uruk were found in fill areas, rubble, and pits, not *in situ* in good archaeological context. Adam Falkenstein, who was epigrapher for the first Uruk seasons when archaic tablets were uncovered (1928-31), established a writing-stage terminology "Uruk IV" and "Uruk III" corresponding to archaeological level. But thereafter he assigned the tablets to one or another writing stage according to similarity of signform. We have followed this latter practice in determining writing stages for tablets found in subsequent excavations. The Jemdet Nasr tablets closely resemble the Uruk III tablets and are considered contemporary with them. The later "archaic" stages represented at Ur (Early Dynastic I period, ca. 2900 BC) and at Fara, Abu Salabikh, and elsewhere

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