The Problem with the Assyrian Numbering System and a proposed Solution

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In our language each letter of the alphabet also represents a number; numbers are written using various combinations of letters. The following table shows each letter with its associated number.

300 ܫ	80 ܨ	40 ܡ	9 ܛ	5 ܗ	1 ܐ
400 ܬ	90 ܨ	50 ܢ	10 ܝ	6 ܘ	2 ܒ
	100 ܩ	60 ܣ	20 ܟ	7 ܙ	3 ܓ
	200 ܪ	70 ܥ	30 ܠ	8 ܚ	4 ܕ

Table 1

To write 1989 we would write ܐ̣ܨܛ; this translates to 1000+900+80+9. The ܐ̣ in this case stands for 1000, not 1, and ܨ stands for 900. The cardinal numbers may have their values modified by using diacriticals, as in the case of Alap and Sadae above. Here are some examples of numbers in Assyrian:

ܫ̈ܢ̈ܐ	351	(1+50+300)
ܝ̈ܗ	16	(6+10)
ܟ̈ܗ	25	(5+20)
ܪܟ̈ܓ	263	(3+60+200)
ܐ̣ܨܥ̈ܛ	2989	(9+80+900+2000)

Conspicuously absent from table 1 is the symbol for zero. In the decimal number system, which uses the Arabic numerals, zero is represented by the symbol 0. No such symbol exists in the Assyrian numbering system. Zero is not merely a convenient symbol; the concept of zero is fundamental to the development of higher mathematics.

The decimal numbering system uses the symbols 0-9 to represent any ordinal numer; this is possible because it includes zero in its set of symbols. Zero acts as a place holder, it modifies the value of the symbol that prcedes it. For example

1 one
10 ten
100 one hundred

the *value* of a symbol depends on its place in the number. Zero is used as a place holder. For example

2 two
20 two times ten
200 two times ten times ten

We state, without proof, the following

1) a numbering system that has a finite set of symbols and that does not have zero cannot represent an arbitrary large number in a reasonable way.

2) a numbering system without zero cannot work in a general way with non-integer numbers.

There are further limitations which we shall not enumerate. As an example, suppose we want to write two million in Assyrian, we would probably have to write the following

. . . 𐫁𐫁 (two thousand Alaps)

whereas in the decimal system we would use 7 symbols (2000000). As an example of (2), we cannot, in general, represent decimal numbers (e.g., 8.0561). This is because the Assyrian numbering system is not a *Place Numbering System*, in which the value of a symbol is determined by its position in the number.

The obvious solution to this problem is to introduce the numeral zero into the Assyrian numbering system, and in so doing make it a Place System. I, therefore, propose the following numeric system

0	7	4	1
	8	5	2
	9	6	3

Including the standard mathematical symbols

. decimal point	() parantheses	/ division
X, * multiplication	+ addition	- subtraction
= equal	> greater that	< less than

and many others.

In this new system the letters ١-٩ retain their meaning; the letter ٠ becomes zero instead of ten. The remaining numeric symbols (٪-٩) are discarded. Here are some examples:

Number	Old System	New System
1989	١٩٨٩	١٩٨٩
2000	٢	٢٠٠٠
306	٣٠٦	٣٠٦
14	١٤	١٤
1.5	?	١.٥
3.06	?	٣.٠٦
.07	?	٠.٠٧

Here are some examples of operations:

Operation	Old System	New System
87	٨٧	٨٧
+96	٩٦ +	٩٦ +
183	١٨٣ (very confusing)	١٨٣ (add from left to right)
2.3	?	٢.٣
+4.8		٤.٨ +
7.1		٧.١
8.05	?	٨.٠٥
-4.08		٤.٠٨ -
3.97		٣.٩٧

The advantages of this system are numerous. First, it frees us from representing numbers in a cumbersome way; it provides an elegant way to represent all types of numbers (integers, fractions, reals, complex numbers, negative numbers), and introduces a flexibility which may be used to great advantage (for example,

we can use scientific notation, or work with numbers in bases other than base 10). Second, it allows us to teach higher mathematics in our language. Third, it allows us to read numbers from right to left instead of from left to right, as is the case when the Arabic numerals are used (which is why we should not use the Arabic numerals).

Commentary

The proposed system is still based on the alphabet; in other words, the first ten symbols of the alphabet are selected to represent the digits 0-9. While the system correctly proposes a place value notation, it still does not free us from associating a particular symbol with its ordinal value in the alphabet i.e., the position of the symbol in the alphabet determines its value. For example, the letter ܐ will have a value of 1 because it is the first letter in the alphabet.

This observation implies that it is not easy to determine that a particular arrangement of symbols in a text is a number, and that the syntax of a number is not easily recognizable. This is because, as mentioned above, the numerical symbols are identical to textual symbols.

This phenomenon becomes a problem particularly in computers. On the one hand, an Assyrian spelling checker would stumble across each number and flag it as being a misspelled word. This may be an inconvenience especially when the spell-checking of a large text with many numbers is involved. On the other hand, how can one propose to assign unique code to numerals to be used in computers, if the symbols are going to be used for both digits and letters?

The latter point would impair the easy execution of the following two requirements:

a) the building of an Assyrian keyboard that generates unique codes for numerals.
b) the checking for a numerical syntactical error when the computer is asked to carry out a numerical calculation.

The author seems somewhat too optimistic in saying that his proposed number system can be used in higher mathematics. He fails to recognize that his system could only be used in isolated elementary arithmetic operations. When it comes to representing an algebraic expression, the proposed system flatly collapses. It is very difficult to write an expression of the form 2^2, 2^b, dx/dy, and so on without any ambiguity. One can not easily determine whether the exponent in ܒ݁ is the numeral 2 or a variable b.

Conclusion

The author has successfully shown that the current numerical notation in the Assyrian language has little or no practical use. It is confusing to use the existing system to represent large numbers or carry out arithmetic operations.

He then proposes a numerical notation based on a place value system. In this system, the position and not the arrangement of a symbol determines its value. For example, the number 32 = 3 x 10 + 2 x 1 and it does not equal to 3+2 or 3-2 as is the case in the Roman numeral system, where IV=5-1 in contrast to VI=5+1.

Unfortunately, however, the symbol set was chosen from the alphabet. I have shown how impractical it would be to use the new system despite its new place value characteristics.

Apparently, a better solution is yet to come. It, perhaps, needs the imaginative mind of someone who would invent a new independent and unique set of symbols to represent digits in the Assyrian language. The shape of the new numerical symbols should be consistent with the general characteristics of the letter shapes in the Assyrian language as well as the directionality of the script as a whole.

Sargon Hasso

This article first appeared in the January-March, 1989 Newsletter of Ashurbanipal Library/Chicago. JAAS is reproducing it, with permission, because it tackles an important topic in an interesting way. Mr. Sargon Hasso's commentary and his critique of certain aspects of the original proposal simply reinforce the central theme of the article.

Accordingly, JAAS commends both Peter Jasim and Sargon Hasso for their innovative ideas in addressing a topic highly relevant to our langauge and culture. Their approach is consistent with JAAS's policy of encouraging original contributions [*Editor*].