# Altered Perspectives and Insight to Algorithm – an Illustration of the Glyph Arithmetic Development of Ethiopic Numbers

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The Ethiopian numeral system was devised following the ancient Greek method of modifying existing members from the character set for the spoken language. The characteristic over bars and under bars indicate a likely Roman influence as well. Unlike either the Romans or Greeks the Ethiopic numerals show a greater mutation from the spoken letters that they may have been based upon. Also, the arrangement of the numerals in the formation of numbers does not have the same kind of cyclic behavior found in Greek, Roman, or the Arabic stems. The algorithm for the glyph arrangement is not immediately apparent and often presents problems even for native users.

This paper will attempt to present graphically the arrangement cycles intrinsic to the system.

The glyphs that make up the Ethiopian numeral system number 20 and are presented in the following :

**Ones**

0 1 2 3 4 5 6 7 8 9

፩ ፪ ፫ ፬ ፭ ፮ ፯ ፰ ፱

**Tens**

10 20 30 40 50 60 70 80 90

፲ ፳ ፴ ፵ ፶ ፷ ፸ ፹ ፺

**Higher**

100 1,000 10,000

፻ ሺ /፲፻ ፼

"ሺ" is often used by Amhara merchants for the value of one thousand, after its word name in Amharic (አማርኛ). The character will not be treated here as if it were a numeral.

Table ፩ shows the core of the 4 stepped development that makes up a single cyclic period in numeric growth.

**Table ፩**

| | | | |
|---|---|---|---|
| ፲ | ፻ | ፲፻ | ፼ |
| 10 | 100 | 1000 | 10,000 |

Table ፪ presents the growth over four periods, or powers of 10,000 (፼). The Arabic equivalent for the end of the period, column 4, is provided on the left-hand side.

**Table ፪**

| | | | | |
|---|---|---|---|---|
| ፲ | ፻ | ፲፻ | ፼ | 1,000 |
| ፲፼ | ፻፼ | ፲፻፼ | ፼፼ | 1,0000,0000 |
| ፲፼፼ | ፻፼፼ | ፲፻፼፼ | ፼፼፼ | 1,0000,0000,0000 |
| ፲፼፼፼ | ፻፼፼፼ | ፲፻፼፼፼ | ፼፼፼፼ | 1,0000,0000,0000,0000 |

We can observe that the character in the 4th column of any row, will carry over into the next row. As if it were a coefficient on the right-hand side (RHS) of the new numeric sequences. We can "factor" this RHS coefficient glyph out of Table 1 to observe more readily the growth of the coefficient. We do so in column 6 of Table ፫ below and recognizing its growth from row to row, we will treat it as a variable across rows.

**Table ፫**

| | | | | | |
|---|---|---|---|---|---|
| (፩) | ፲ | ፻ | ፲፻ | ፼ | |
| (፩) | ፲ | ፻ | ፲፻ | ፼ | ፼ |
| (፩) | ፲ | ፻ | ፲፻ | ፼ | ፼፼ |
| (፩) | ፲ | ፻ | ፲፻ | ፼ | ፻፼፼ |

Columns 2 - 4 now reveal again the cyclic pattern within the numeral development as seen first in Table ፩. The orders of 10000 are factored to the right in column 6. The right being the side that the glyphs (፼) are appended to on the 4 cyclic variables. There was an implied coefficient of 1 (፩) living in the template and now revealed in the 1st column. We have not seen it before due to the nature of a decimal (base 10) series :

1 × 10 = 10
፩ × ፲ = ፲

For Ethiopic numerals, this trait breaks down when the multiples of 10 up to 90 are considered. Each such multiple will have unique a character representations, which introduces a 2nd type of cyclic behavior to arrangement of the numeral in numeric growth.

It is now wise to assign a new variable to left coefficient, we do so with ኸ and introduce another ቸ that will always be equal in value to 10ኸ or more appropriately ኸ፲.

Suppose the coefficient before the orders of 10 is no longer singular. Let the coefficient be ፫ (3) then ኸ = ፫ and ቸ = ፫፲ = ፴. Table ፬ represents Table ፪ with the LHS coefficient ፫.

**Table ፬**

| | | | |
|---|---|---|---|
| ፴ | ፫፻ | ፴፻ | ፫፼ |
| ፴፼ | ፫፻፼ | ፴፻፼ | ፫፼፼ |
| ፴፼፼ | ፫፻፼፼ | ፴፻፼፼ | ፫፼፼፼ |
| ፴፼፼፼ | ፫፻፼፼፼ | ፴፻፼፼፼ | ፫፼፼፼፼ |

Table ፬ can be shown as the combination of two other tables, Table ፫ and a second table holding the alternating LHS coefficients :

| | | | | |
|---|---|---|---|---|
| | ፻ | ፻ | ፼ | |
| | ፻ | ፻ | ፼ | ፼ |
| | ፻ | ፻ | ፼ | ፼፼ |
| | ፻ | ፻ | ፼ | ፼፼፼ |

+

| | | | | |
|---|---|---|---|---|
| ፴ | ፫ | ፴ | ፫ | Left coefficients added for each row. |

There remains a final reduction for our developing numerical composition algorithm. Table ፬ which shows the growth of the rows for increasing powers of ፼, may be reduced to a single row with an exponent given on the RHS variable like so:

| | | | | |
|---|---|---|---|---|
| | ፻ | ፻ | ፼ | ፼ን ( ን = 0 → infinity ) |

ን becomes the number of ፼ that will be appended on the RHS.

+

| | | | | |
|---|---|---|---|---|
| ቾ | ኽ | ቾ | ኽ | LHS Coefficients. |

Note here that the ኽ coefficient appears in the columns where the number of zeros (“0”s) is odd in Table ፩, and that ቾ appears in the columns showing an even number of zeros.

A recombination follows but requires the special rule for omitting ፩ (1) as a left-hand side coefficient except for the second special case of ፼$^0$ which occurs only in the in the first column of the first row.

**Reduced Glyph Composition Algorithm :**

10 100 1,000 10,000 ኽ(10,000ን)

ቾ* ኽ፻ ቾ፻ ኽ፼ ፼ን *(ን = 0 → infinity)*

ኽ = ፩ → ፱ (ኽ = 01 → 09) *ኽ for even number of zeros.*

ቾ = ኽ፲→ ፲ → ፺ (ቾ = 10 → 90) *ቾ for odd number of zeros.*

* *Special rule for combination with ፩ (1)*

The Ethiopian numerals are not commonly used these days for more than giving calendar years. With 1987 as both a unitless number and as a year for an example, we can demonstrate the arrangement of the numerals required to construct each.

**The Number 1987 :**

```
1987 =  1,000 + 9×(100) + 80 + 07
     =     ፲፻   + ፱×፻      + ፹  + ፯
     =  ፲፻፺፻፹፯
```

**The Year 1987 :**

```
1987 =     19x(100) + 80 + 07
     = (10+9)×(100) + 80 + 07
     =  ፲፱ × ፻   + ፹ + ፯
     =  ፲፱፻፹፯
```

# Author's Note

This article is the 2nd in a series of numeral algorithms developed and published over several years. While the algorithm presented is believed to be valid, the paper should be considered as having been superseded by later papers, and ultimately the final paper: *A Look at Ethiopic Numerals*.

**The complete numeral algorithm series:**

- 1994, *Another View of Ethiopic Number Sequences*, originally posted to the "EthioSciences" email list of the EthioList mail server. Then later published as a web page under the Abyssinia Cyberspace Gateway: http://abyssiniagateway.net/fidel/EthNumbers.html , at Academia.edu https://www.academia.edu/127879191/Another_View_of_Ethiopic_Number_Sequences

- 1995, *Altered Perspectives and Insight to Algorithm – an Illustration of the Glyph Arithmetic Development of Ethiopic Numbers,* Abyssinia Cyberspace Gateway, http://abyssiniagateway.net/fidel/Enums.html , at Academia.edu https://www.academia.edu/127879201/Altered_Perspectives_and_Insight_to_Algorithm_an_Illustration_of_the_Glyph_Arithmetic_Development_of_Ethiopic_Numbers

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- 2000, *A Look at Ethiopic Numerals*, 2000, https://www.geez.org/Numerals/, Geez.Org. A form of this article was published under the title *"Conversion and Formatting of Ethiopic Numerals"*, in Multilingual Magazine, November, 2000. At Academia.edu https://www.academia.edu/127115901/A_Look_at_Ethiopic_Numerals