The Mayan zeros

**Headnote**

The introduction of zero allowed the "average man" to do mathematical calculations

The introduction of the symbol for zero was one of the most significant events to occur in the history of civilization. Until zero was considered a number in its own right and given a symbol, performing more than simple calculations was impossible without a calculating device, such as an abacus. Only specialists knew how to use these devices. Tobias Dantzig says that the most important thing that the creation of the symbol for zero did was to allow the "average man" to do mathematical calculations (Dantzig 1941, p. 35). The Hindus of India created the symbol for zero in the form that most of the world uses today, but another culture far removed from the Hindus invented its own system of place value with the use of a zero. In fact the Maya of Central America used more than one symbol for zero.

MULTIPLE SYMBOLS FOR ZERO

We may never really know why the Maya used multiple symbols for zero, because only a few records exist from the Mayan civilization, a civilization that began about the fifth century B.C. and began to decline about A.D. 900. Georges Ifrah explains that very few written records about the Maya remain because their civilization had waned by the time the Spanish arrived in the sixteenth century and because many of the records had simply deteriorated (Ifrah 2000, p. 300). To make matters worse, the Franciscan monk Diego de Landa burned the written records that the Mayan people had left, thinking that the absence would make them more willing to convert to Roman Catholicism. Reports have suggested that when he realized the impact of his action, de Landa spent the rest of his life collecting information from surviving Maya and transcribing all that they could remember from their past. De Landa's account, comprising three codices that are housed in Madrid, Dresden, and Paris, as well as a few accounts from converts who later learned to read and write Spanish, are all that remain as written records of the Maya.

We can conjecture that one reason that the Maya had multiple symbols for zero is that they used two types of numerals. The first type are glyphs called head variants because they show the head of a god, a person, or an animal. The second system, which evolved from these glyphs to facilitate ease of calculation, used a dot or a circle for units and a bar for fives. The head-variant numerals are illustrated in figure 1 (Closs 1986, p. 335). These glyphs each represented a unit of time and were used when the simpler form of the dot, bar, and shell was not suitable. Besides the simpler form and the head-variant glyphs, a third, rarely used, numeral form depicted the full figure of the god. The "full-figure representation of '0 kins,'" or days, is shown in figure 2 (Ifrah 2000, p. 320).

In The Crest of the Peacock: Non-European Roots of Mathematics, Joseph (1992) illustrates the use of the simple form of glyph by showing that the Mayan number for the quantity three had three dots; that ten was represented by two bars, either vertical or horizontal; and that the number for nine had four dots and one bar. A shell was used to signify zero, so, for example, twenty was represented by one dot and one shell in the Mayan base-twenty system. Figure 3 gives an example using the dot, bar, and shell (Joseph 1992, p. 50).

THE MAYAN LONG-COUNT SYSTEM

The Maya created their number system mainly for calendar use. This system was called the long-count system and used units of days and a calendar year of 360 days. When the Maya counted such animate objects as people and animals, they used a strictly vigesimal, or base-twenty, system; but when they counted time, their system had an irregularity at the third order of units, where 18 x 20 was used instead of 20 x 20. Without this irregularity, their year would have contained 400 days instead of the desired 360 days. The irregularity continues from the third order of units on. Figure 4 shows how this system works (Ifrah 2000, p. 311).

The order of units in the long-count system was counted in kins (days), uinals (20-day months), tuns (360-day years), katuns (cycles of 20 years), baktuns (cycles of 400 years), and so on. On their lavishly decorated monuments, or stelae, the Maya represented years either by glyphs, which were assigned values according to their place value, or by the simpler dot-bar-shell number system (Ifrah 2000, p. 316). Although we may find the practice strange, the Maya used different symbols for zero depending on the position that the zero inhabited in the calculation. Figure 5 shows the different forms of zero that were used in de Landa's codices to indicate the absence of units of a particular order (Ifrah 2000, p. 310).

The Maya placed the glyphs vertically on the stelae. The time units, from the kin to the baktun, always appeared on the stelae in order of magnitude in "floors"; they were read from the top to the bottom. First-order units were placed on the "bottom floor" of the stela, followed by the multiples of twenty on the "second floor"; at the third position, or "third floor," the multiples took up the irregular form of 18 x 20 = 360; and so on. When any time unit was missing, a suitable sign was needed to indicate its absence. This practice led the Maya to devise their remarkable written place-value numeration system with a genuine zero. Figure 6 shows the use of different forms of seashells used for zero in representing the missing units of certain orders of the number 1,087,200: (7 x 144,000) + (11 x 7,200) + (0 x 360) + (0 x 20) + (0 x 1) (Ifrah 2000, p. 309).

CONCLUSION

Barrow explains that contemporary readers more easily understand the Mayan use of zero when "we realize that the Mayans depicted periods of time and other quantities as pictures in which each part of the design symbolized a part of the total sum" (Barrow 1992, p. 89). His example explains that "one hour, one minute and five seconds" would have three "ingredients to fill the frame allowed for it." Unless a glyph for zero is available, the overall picture for five seconds would have two empty spaces.

Although the Mayan place-value number system was mainly used for calendar purposes, it was a fully functioning system for calculation. The Hindus and the Maya share the distinction of being the only two cultures that introduced an original symbol for zero. Dantzig sums up with the statement that "in the history of culture the discovery of zero will always stand out as one of the greatest achievements of the human race" (Dantzig 1941, p. 35).

**References**

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