The Classic Maya Calendar and Day Numbering System

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Introduction

The calendar systems used in the ancient world reflect the agricultural, political and ritual needs characteristic of the societies in which they flourished. Astronomical observations to establish the winter and summer solstices were in use three to four millennia ago [1]. By the 14th century BCE the Shang Chinese had established the solar year as 365.25 days and the lunar month as 29.5 days. The lunisolar calendar, in which the ritual month is based on the Moon and the agricultural year on the Sun, was used throughout the ancient Near East (except Egypt) and Greece from the third millennium BCE. Early calendars used either thirteen lunar months of 28 days or twelve alternating lunar months of 29 and 30 days and haphazard means to reconcile the 354/364-day lunar year with the 365-day solar year.

The study of historic and modern calendar systems is a fascinating adventure involving interlocking political, religious and economic agendas. A reconciliation of the various modern calendar systems suffered by computer systems of the world is given in [2]. The conciliation adopted by the Network Time Protocol is given in [3]. The following discussion of the Classic Maya calendar is based on the comprehensive history of the Maya given in [5]. Before we start, a note on the terms of reference. The term *Maya* is used by historians as both a noun and an adjective to refer to the people, their culture and their artifacts. However, there are many related languages of the Maya; therefore, historians use the term *Mayan* to refer to the family of Maya languages, both as a noun and adjective.

The Classic Maya civilization of southern Mexico, Guatemala and Belize flourished in the fourth through tenth century CE. They were accomplished astronomers and crafted a fascinating calendar system. They used a vigesimal (base-20) number system including the concept of zero long before Europeans expunged the Roman numerology. The Maya system uses only three symbols for zero (a shell-shaped glyph), one (a dot) and five (a bar) to represent units from zero through 19. For instance, the number 13 was represented as three dots and two bars. A positional notation was used in which each viget position represents the days in increasing powers of 20, except for the second position (months), where the radix is 18 instead of 20. This system was used to represent both absolute dates of prominent events, such as conquests, ascendancies and so forth, and relative dates.

The Maya Calendar

The Maya actually used two calendars, a sacred year of 260 days and a vague year of 365 days. Along with other Mesoamerican peoples, the Maya use the sacred year for religious purposes and to name children, for example. The

vague year is used for such things as planting crops. The least common multiple of the two calendars, called the *calendar round*, has 18,980 days or 73 sacred years or 52 vague years. A Maya month or *uinal* consists of 20 solar days or *kins*. The 260-day sacred year or *tzolkin* consists of 13 months of 20 days, while the 365-day vague year or *haab*, consists of 18 months of 20 days, called the *tun*, followed by an intercalary "month" of five days called the *uayeb*.

Longer cycles can be incorporated in the Maya calendar. A *katun* consists of 20 tun (about 19.7 years), a *baktun* of 20 katuns (about 395 years), a *pictun* of 20 baktuns (about 78.9 centuries), a *calabtun* of 20 pictuns (about 158 millennia), and a *kinchiltun* of 20 calabtuns (about 3.16 million years). There is evidence to suggest the Maya were aware that the vague year differed slightly from the actual solar year, but no evidence they actually did something about it.

Days of either the sacred year or vague year are represented by articulated viget-glyph digraphs similar to the figure at left. The *overt viget* on the left of the figure encodes 14 as described above. The glyph on the right, called a *day glyph*, encodes a *vague viget* depending on its face.

A calendar round date consists of two digraphs representing the sacred-year day followed by the vague-year day. When necessary, years are represented in positional notation, where each overt viget represents a coefficient and the opaque viget the positional multiplier or *year glyph*. The format varies somewhat according to the style of the calendrist, with the overt viget placed on the top or on the left as in the figure, which is literally translated 14 Pictun (about 103 centuries).

Historians number the sacred year in month numbers one through 13 and day glyphs corresponding to numbers one through 20. In this format there are no month glyphs. The day numbers, glyphs and names are:

Day	Glyph	Name	Day	Glyph	Name	Day	Glyph	Name	Day	Glyph	Name
1		Imix	6		Cimi	11		Chuen	16		Cib
2		Ik	7		Manik	12		Eb	17		Caban
3		Akbal	8		Lamat	13		Ben	18		Etznab
4		Kan	9		Muluk	14		Ix	19		Cauac
5		Chicchan	10		Oc	15		Men	20		Ahau

Each succeeding day causes both the day number and glyph number to advance by one, e.g., 1 Imix, 2 Ik, ..., 13 Ben, 1 Ix, 2 Men, and so on. Since 13 and 20 have no common divisors, this system uniquely represents all 260 days of the sacred year.

Historians number the vague year in day numbers zero through 19 and month glyphs corresponding to numbers one through 19, where the last month represents the five uncounted days of the haab. The month numbers, glyphs

and names are:

Month	Glyph	Name	Month	Glyph	Name	Month	Glyph	Name	Month	Glyph	Na
1		Pop	6		Xul	11		Zac	16		P
2		Uo	7		Yaxkin	12		Ceh	17		Ka
3		Zip	8		Mol	13		Mac	18		Cu
4		Zotz	9		Chen	14		Kankin	19		Ua
5		Tzec	10		Yax	15		Muan			

Each succeeding day causes the day number to advance by one. When the day number wraps from 19 to zero (or in the month of *uayeb* from 4 to zero), the month glyph advances by one. For instance, a Maya day written 0 Pop is followed by 1 Pop, ..., 19 Pop, 0 Uo, 1 Uo, and so on. A calendar round date consists of the sacred day concatenated with the vague day, e.g., 2 Yaxin 10 Ahau. A unique combination of sacred day and vague day recurs only once in the calendar round, where the beginning of each round is established at the correspondence 2 Ik 0 Pop.

The Calendar Round and Long Count Dates

Historians write a Maya *long count* calendar round date in the form, e.g., 9.17.0.0.0 13 Ahau 18 Cumku, where the first five viget fields designate the baktuns, katuns, tuns, uinals and kins in order. The next digraph designates the sacred day of the calendar round and the last digraph the vague day. The Maya engraved long count dates on stone monuments called *stellae* as 15 digraphs reading from top to bottom. At the top is a variant of the *alautun* glyph. Just below this are five digraphs representing the count of baktuns, katuns, tuns, uinals and kins, as shown below.

Years	Viget	Glyph	Name
3.1 megayears			Long Count
158 centuries	9		Baktun
7.9 centuries	17		Katun
394 years	0		Tun
19.7 years	0		Uinal
years	0		Kin
sacred day	13		Ahau
		...	

vague day	18		Cumku

Other engravings include kinchiltuns  , calabtuns  , and pictuns  . The next digraph represents the sacred day and, after some intervening glyphs, the last of the 15 digraphs represents the vague day.

Reckoning the Maya and Gregorian Calendars

A point of considerable historic interest is the conciliation of the Maya and Gregorian calendars. This amounts to (a) selection of an origin for the initial long count, (b) selection of the calendar round corresponding to that count, and (c) correlating a specific long-count date on the Maya calendar with the corresponding date on the Gregorian calendar. The Maya reckoned their chronology in *great cycles* of 13 baktuns (about 5,128 solar years), with the beginning of the current cycle 13.0.0.0.0 4 Ahau 8 Cumku corresponding to a day in 3114 BCE. This establishes the relationship between the long count and calendar round numbering.

The generally agreed upon correlation between the Gregorian and Maya calendars is the Goodman-Martinez-Thompson (GMT) correlation, which places the long count katun ending 11.16.0.0.0 13 Ahau 8 Xul on 14 November 1539 (Gregorian). While the GMT is convenient for calendric calculations, it should be noted that the Gregorian calendar has itself existed only since 15 October 1582 as proclaimed by Pope Gregory XIII [4]. It is an interesting, but intricate, exercise to construct spreadsheet programs which convert between Gregorian and Maya calendars. For instance, for today 14 August 1995, my Excel 5 spreadsheed program displays Modified Julian Day 49943 and Maya long-count date 12.19.2.7.0 8 Ahau 8 Uo.

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