

**MAYA MATH,
MAYA INDIANS
AND INDIAN *MAYA*:**

**REFLECTIONS
ON NUMBERS,
HISTORY AND
RELIGION**

By

**Abdul Hai Khalid
Professor
Department of Mathematics
Niagara College,
Welland, Ontario, Canada**

Summary

The Maya culture of Central America invented an advanced, base-20, place value based number system, using a symbol for zero, almost at the same time as our, base-10, 'Hindu-Arabic' numerals were invented in India. This presentation describes the Maya number system and places it in the historical context of the development of other number systems around the world, e.g., Egyptian, Roman, Mesopotamian, Chinese and Indian etc. The ease, or difficulty, of the basic arithmetic operations, in different number systems, is discussed. The history of the spread of the 'Hindu-Arabic' numerals from India to the Middle East to Europe is described. The implications of an advanced number system on the philosophies, religions and world-views of different cultures are discussed.

Contents

Who are the Maya?

Maya Mathematics

Maya Calendar

Number Systems Around the World

Additive

Multiplicative

Place Value Based

Spread of Indian Numerals

Numbers, History and Religion

WHO are maya ?

Maya people live in southern Mexico and the central American countries of Guatemala, Belize, Honduras and El Salvador. Ancient Maya culture flourished in this area between 1000 B.C. and 1000 A.D. The ruins of many ancient Maya cities have been found in this area. Some of these are Chichen Itza, Coba, Tulum, Palenque and Tikal etc. These cities contain pyramids, temples, palaces, ball courts and roads etc.

- Meso-american Civilizations: Olmec (the ‘mother civilization’), Maya, Toltec, Mixtec, Aztec etc**
- Maya were the cultural high point of meso-american civilizations**
- Used a hieroglyph based writing system**
- Had accordion-like books written on tree barks; had large libraries; mostly burnt down by the Spanish conquistadores**
- Books on history, astronomy, astrology, religious rites, festivals, culture and agriculture etc**
- Built large cities, pyramids, monuments, ball courts**
- Government consisted of city-states**
- No beasts of burden, no wheels, no iron**
- Early Maya relatively peaceful; later practiced human sacrifices under the influence of central Mexican cultures**

Why did the maya need math?

Maya were great builders. They made many large and complex buildings and monuments. Their cities were well planned. They were good astronomers. They had a very complex calendar, consisting of several different cycles. These consisted of a 260-day cycle, a 365-day cycle, an 18,980-day (52 years) cycle and an enormous 1,872,000-day (about 5100 years) cycle. They were using large numbers in their calculations. Obviously they needed a good and efficient number system. As they say, need is the mother of inventions.

Maya number system is far more efficient than the Roman numerals, which were being used at about the same time. The Roman numerals used symbols, I, V, X, L, M, etc whose values are not based on place values. Even our (Hindu-Arabic) number system uses ten symbols (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9) whose shapes do not follow any logic or rules. Maya numbers are elegantly made of only three symbols and are written according to a place value based system like ours.

Our Number System

Our number system is called ‘Hindu-Arabic’. It started in India in early centuries A.D. Arabs passed it on to the Europe. Our number system is a place value based system, with base 10. The digits on the right have lower place values and digits on the left have higher place values. Place values increase in multiples of 10, i.e., ones, tens, hundreds, thousands etc. For example, the number 3205 means:

$$3 \times 1000 + 2 \times 100 + 0 \times 10 + 5 \times 1$$

Using a place value based system, addition, subtraction, multiplication and division can be performed very easily. For example when adding two numbers we align ones under ones, tens under tens and hundreds under hundreds etc.

Before the introduction of the Hindu-Arabic place value based system, Europeans were using Roman numerals. Simple math was not easy in Roman numerals. For example try the following problems (note: you are not allowed to change the Roman numerals into Hindu-Arabic numerals):

(1) MCMLXXXVIII + MCMXIV = ?

(2) MCMLXXXVIII - MCMXIV = ?

(3) MCMLXXXVIII x XXIV = ?

Maya Number System

- Vigesimal (Base 20)**
- Counted on fingers and toes**
- Positional, place-value based, numbers found on monuments from 36 BC**
- Shell or eye shaped zero appears between AD 292 and 357 (?)**
- The whole system based on only 3 symbols**
- Numbers less than 20 are written in a base 5, additive system**
- Numbers equal or greater than 20 are written vertically, using places with increasing powers of 20 – 20^0 (1), 20^1 (20), 20^2 (400), 20^3 (8,000), 20^4 (160,000) etc**

Advantages of Maya Math

- Only 3 symbols
- Single digits (1 to 19) have logical shapes, easy to remember
- Single digit addition and subtraction are concrete and visual (e.g., $6 + 7 = 13$):

$$\begin{array}{c} \cdot \\ \text{----} \end{array} + \begin{array}{c} \cdot\cdot \\ \text{----} \end{array} = \begin{array}{c} \cdot\cdot\cdot \\ \text{====} \end{array}$$

- Pedagogic advantage: Would save time (a year?) in primary school, if we switch to Maya symbols for numbers 1-9. (Keeping our base-10 system, only changing the shapes of the numerals 1-9)

Summary of Maya Math

3 basic symbols:

Dot (.) = 1, Bar (—) = 5, Eye (O) = zero
 (Sorry, can't draw bar and 'eye' very well)

Numbers 1-19 are additive:

| | | | | |
|---|----|-----|------|---|
| · | ·· | ··· | ···· | — |
| 1 | 2 | 3 | 4 | 5 |

| | | | | |
|---|----|-----|------|----|
| · | ·· | ··· | ···· | — |
| 6 | 7 | 8 | 9 | 10 |

| | | | | |
|----|----|-----|------|----|
| · | ·· | ··· | ···· | — |
| 11 | 12 | 13 | 14 | 15 |

| | | | |
|----|----|-----|------|
| · | ·· | ··· | ···· |
| 16 | 17 | 18 | 19 |

20 onwards place-value based system operates. The bottom place is units (20^0), next up 20s (20^1), the next up 400s (20^2), the next up 8000s (20^3), and so on. Examples:

(1) 20

20s: . 1x20
 1s: O 0x1

(2) 64

20s: ... 3x20
 1s: 4x1

(3) 400

400s: . 1x400
 20s: O 0x20
 1s: O 0x1

(4) 4,013

400s: === 10x400
 20s: O 0x20
 1s: ... 13x1
 ===

(5) 32,202

8000s: 4x8000
 400s: O 0x400
 20s: === 10x20
 1s: .. 2x1

- Maya numbers can be added , subtracted, multiplied and divided using algorithms very similar to our base-10 math.

-Ideas of ‘Carry over’ and ‘borrow’ are same as ours

Ancient Applications of Maya Math:

- Calendar, time keeping for rituals, festivals, sacrifices, agriculture etc

- Astronomy, astrology

- Buildings, monuments, architecture, and

- Counting of votes!!! By the middle of the first millennium AD, some of the Maya city-states had transformed from monarchy to the rule by a ‘brotherhood’. The brotherhood consisted of about 10% of a city’s population, and included women. For example, Chichen-Itza had a population of about 65,000. Hence, the ruling brotherhood would consist of about 6,500 people. Decisions were made collectively. Very similar to the ‘democracy’ in Greek city-states!

Maya Calendar

- **A culture obsessed with time**
- **Had auspicious and dangerous dates**
- **Birth day determined the fate of a person (not unlike astrology in other cultures)**

- **Tzolk'in: 260-day (20 days x 13 months) sacred year. Used to plan rituals, feasts, sacrifices etc**

- **Haab: 365-day civil year, based on the solar cycle; 18 months of 20 days each plus the 5-day 'dangerous period'.**

- **Tun: The 360-day 'vague year' - an approximation of Haab. Used for long calculations.**

- **Maya date is specified by the following 4 parameters:**

Date (1-13), Tzolk'in day name (20);

Date (0-19), Haab month name (18+1)

- Solar years adjusted, very precisely, in a way similar to our leap years. After the adjustment, the average year amounts to:

Mayan year = 365.242 000 days

Astronomical year = 365.242 198 days

Georgian year = 365.242 500 days

(from:Pi in the Sky by John Barrow, p87)

Mayan Calendar round or cycle (52 years): When the sacred (Tzolk'in) and civil (Haab) years, repeat.

Tzolk'in = 260 days = $2 \times 2 \times 5 \times 13$ days

Haab = 365 days = 5×73 days

LCM = $2 \times 2 \times 5 \times 13 \times 73$ days = 52 years

⇒ The two repeat after every 52 years

Maya Long Count:

| | |
|-----------------------|---|
| 20 K'ins (day) | = 1 Winal (month) |
| 18 Winal | = 1 Tun (360 days) |
| 20 Tun | = 1 Ka'Tun ('decade') |
| 20 Ka'Tun | = 1 Baktun ('century') |
| 20 Baktun | = 1 Pictun |
| 20 Pictun | = 1 Calabtun |
| 20 Calabtun | = 1 Kinchiltun |
| 20 kinchiltun | = 1 Analtun (20⁶ years, i.e., 64 million years) |

... .. goes up to hundreds of trillions of years

Mayan age of the universe: 2×10^{27} years
(Teresi, p 85)

Today's date: May 25, 2005

**Equivalent Maya date: 6 Ben, 11 Zip,
12.19.12.05.13, i.e., 12 baktun, 19 katun, 12 tun, 5
winal, 13 k'in.**

To convert any date into Maya date, go to:

<http://www.michielb.nl/maya/calendar.html>

-Mayans were afraid of time running out (like our Millennial cults).

-Devised the elaborate calendar, consisting of several cycles, so the dates do not repeat, and hence the time does not run out.

- Mayan creation myth: 5 attempts at creation

- In 4 earlier attempts, god, used mud and monkeys etc – results not satisfactory; destroyed.

- Human beings are the 5th attempt at creation, using maize dough – We are still in ‘in probation’.

- Our creation date, according to Maya myth: 7.00.00.00.00 (3133 BC)

- This Pictun (8000 years; ‘millenium’) ends on Dec 24, 2011.

- If the gods are not satisfied with the current creation experiment, we (human beings) might be destroyed on the above date. (McLeish, p 135-136)

Hence, the Christian millennial cults had probably got it wrong! End of the world might actually be coming in 2011! *Please don't tell anybody.* Who knows we will soon witness, new millennial cults starting in Mexico and spreading to US!

Counting in Animals

- **Visual counting: Most birds can ‘count’ up to 4-5 (i.e., can distinguish between 4 and 5 things).**
- **Cats, for example, usually give birth to a litter of up to 6. Evolution must have equipped them to distinguish between 5 and 6, for the survival of their litter.**
- **Human beings can visually count up to 8-9, i.e., can visually differentiate between 8 and 9 (Teresi).**
- **For higher numbers we need markers, e.g., fingers and toes.**
- **Left parietal lobe controls both finger manipulation and counting. Gerstmann’s Syndrome: Loss of both abilities.**
 - ⇒ **Counting is “off-line” finger manipulation.**
- **Counting using tally marks goes back to tens of thousands of years. More than 30,000 year old bones found with tally marks, some grouped in fives.**
- **Some tribes still, do not have any words to count numbers more than 2. Their counting goes: One, Two, Many. This does NOT mean, however, that they can’t distinguish visually between, say 6 and 7.**
- **Different cultures had developed counting systems using various bases, e.g., 5, 10, 20 and even 12 (our dozen is a relic of base 12 counting) and 60 in ancient Mesopotamia (our minute, second and angle measurements are relics of base 60 counting).**

Number Systems

Generally, all number systems can be divided into 3 types: additive, multiplicative and place-value based.

Additive: There are different symbols for 1, 10, 100, etc. Any number can be written using an appropriate collection of each symbol. Requires a large number of symbols to write big numbers.

Examples: Egyptian, Greek, Hebrew, Old Arabic etc. The Roman numerals are a modified form of additive numerals.

Multiplicative: Multiplier symbols are used to write large numbers in a more compact form. For example, the symbol of 7 written together with the multiplier symbol for 1000 would mean 7000 (does not require to write the symbol for 1000, seven times). Still need new multiplier symbols to write bigger numbers. More advanced than additive systems, but not as good as the place value based ones.

Examples: Chinese and some early Indian systems.

Place-Value Based: This is the next stage in the evolution of number systems. The multiplier symbols are dropped and the place where a digit is written itself signifies the multiplier, e.g., tens, hundreds or thousands etc. A symbol for zero is essential at this stage to denote empty places, e.g., the zero in 202 means no tens. Does not need to invent new symbols to write very large numbers. Just keep on adding zeros.

Examples: An early example was the Babylonian base-60 numerals. However, Babylonians never used zeros at the end of a number, hence this system was not fully developed. Chinese ‘stick numerals’, which were used on the counting boards can be regarded as a sort of place value based system because the empty rectangles, on the counting board, are equivalent to zeros. However, they had no explicit symbol for zero.

Indian and Maya numerals are the only two full-fledged place value based number systems, using zero symbols.

Additive Number Systems

Egyptian, Greek, Hebrew, Arabic etc

- Each power of ten, e.g., 1, 10, 100, 1000 etc denoted by a different symbol.

- Any number can be written by drawing an appropriate collection of these symbols.

- e.g. Egyptian: one = I, 10 = ∩

**Hence, 76 = III ∩∩∩∩
 III ∩∩∩**

- Problems: Large numbers require too many symbols; need to invent a new symbol for every power of ten; addition, subtraction involve rearrangement of these symbols; multiplication, division etc become quite hard. Only experts can do it, using abacus or counting boards etc

Roman Numerals: Modified Additive

| | Egyptian | Roman |
|-----------|------------------|--------------|
| 14 | IIII ∩ | XIV |
| 16 | IIIII ∩ | XVI |
| 19 | IIIIIII ∩ | XIX |

- **Try to save space by introducing:**
 - **Mid-value symbols: V etc**
 - **Relative positions: e.g., IV, VI**
- **Made calculations much more difficult, however**
- **Try to multiply: MCMXCVIII by XXVIII (Condition: Do it without changing into Hindu-Arabic numerals!)**
- **Commonly used in Europe until 16th century**

Chinese numerals

- **Multiplicative**
- **Multipliers for 10, 100, 1000, 10000, 100000 etc instead of place values.**
- **Written vertically.**
- **Can write large numbers in a more compact form than additive systems.**
- **However, still need to invent new symbols as larger and larger numbers are written.**
- **Stick (Counting Board) numerals were sort of place-value based.**
- **Empty rectangular place implies zero.**
- **However, no explicit symbol was used for zero, and zero was not indicated in the written form.**
- **No official zero until Chin Chiu Shao's work in 1247.**
- **Better than additive number systems, but not as good as place value based ones.**

Babylonian Place Value System

- In use since about 2000 BC?**
 - Place values: Powers of 60: 60, 3600 etc.**
 - Our measures of time, angles etc are a relic of the Babylonian base-60 system.**
 - Were using a zero symbol for empty places (700-300 BC).**
 - However, never used zero at the end (or RHS) of the numbers.**
 - Hence had an inherent ambiguity: e.g., 60 and 3600 can't be distinguished**
 - Used different symbol sizes or context etc to overcome this ambiguity**
- ⇒ Not a full-fledged zero**

Hindu-“Arabic” Numerals

- Evolution of place value system and the zero: 1st-8th century AD**
- Earliest versions from late BC and early AD**
- Fully evolved Gwalior numerals (from which are present numerals are derived) date from 8th century AD. The exact shapes of these numerals, however, drifted and acquired different forms as they spread to Arabia, Spain etc in the west and to Thailand and Cambodia etc in the east.**

Recognition of Zero as a Number

- From the early centuries AD, Indians had realized that zero is not just a symbol to denote empty places, but a full-fledged number in its own right, and that the various arithmetic operations apply to zero as well as to other numbers. This realization soon led to the idea of negative numbers.

- The Indian mathematician, Brahmagupta, summarized these properties around 600 AD, as follows:

Zero is neither +ive nor -ive

Forms the boundary between +ive and -ive numbers

$$a + (-a) = 0$$

$$\pm a \pm 0 = \pm a$$

$$0 \pm 0 = 0$$

$$0 \times 0 = 0$$

$$0 / a = 0$$

$a / 0$ is undefined

$$\sqrt{0} = 0$$

$$0 / 0 = 0 \text{ (!!!) (Not correct)}$$

Kinds of Zero

Hence, we can summarize the development of the idea of zero in the following three stages:

(1) Caveman's zero: Recognition of absence of something, emptiness ...

None, Nil, Null, Rien, *Mayo* ...

**For example: A caveman returned from a hunting trip. His wife asked him: How many buffalos did you get?
Answer: none**

(2) Positional zero: Used to denote empty places in a place-value based system, e.g.,

- **Babylonian zero ***
- **Maya zero**
- **Indian zero**
- **Chinese zero ***

*** Not full-fledged zeros**

(3) Zero, recognized as a number in its own right and its mathematical properties studied (e.g., Brahmagupta, AD 600)

⇒ **Negative numbers follow.**

Zero the Hero

- Removes ambiguity in the value of numbers, e.g., 44, 404 and 440.**
- Makes it easy to write and think of big numbers (Keep on adding zeros).**
- Makes possible easy algorithms for addition, subtraction, multiplication, division etc.**
- Takes the ‘magic’ out of medieval arithmetic. Previously, common people were in awe of the ‘high priests’ who made calculations using abacus or some other tricks.**
- Leads to the idea of negative numbers.**

Greek Big Numbers (Kaplan, p. 28-35)

- Some cultures tried to describe large numbers without using zero or an advanced place value based number system.
- Myriad = 10,000 (Largest number which the Greeks could write in symbolic form. To describe higher numbers Greek philosophers/ mathematicians used 'names' or words rather than symbols.)

For example, Archimides (born 287 BC) has discussed some big numbers:

10^8 = Myriad myriad

1st 'order' numbers: 1 - 10^8

2nd 'order' numbers: up to 10^{16}

3rd 'order' numbers: up to 10^{24}

... ..

$10^{8^{\text{th}}}$ (!!)'order':

$(100,000,000)^{99,999,999}$ to $(100,000,000)^{100,000,000}$

The above 10^8 'orders' make the first 'period'.

- Now, the 'periods' repeat in the above manner.

... ..

- Unimaginably large numbers; but too abstract, not concrete.

- Cannot be described in symbolic form, can only be expressed in terms of words (which only philosophers could understand)

⇒ Beyond the grasp of common man.

Indian Big Numbers

“... a country where gigantic stretches of time and space and frightening numbers of creatures are the commonplaces of the myth and folklore” (Kaplan, p37)

**The book, Lalitavistara (about 0 AD), gives an exaggerated account of the young Buddha, recounting in his math exam, all numerical ranks bigger than a Koti (10^7), in successive multiples of 100 as:
Ayuta, niyuta, kankara, vivara, achobya, vivahautsanga, bahula, nagabala, titilambha, vyavaithanaprajnapti (10^{31}), ...samaptalambha (10^{37}), ... visandjnagati (10^{47}), ... talakchana (10^{53}).**

This was just the first level!

2nd level: up to 10^{99} ,

9th level: up to 10^{421} .

Influenced by Greeks? (Kaplan, p 38); or vice-versa?

- **With the invention of zero the big number terminology well established in India in late BC or early AD**
- **Indian Age of the world: Hundreds of billions of years.**
- **Present cycle: 4.3 billion years.**
- **Modern Geophysics: 4.6 billion years.**
- **In comparison, billions, trillions etc, in the West, are fairly recent terms.**
- **For example: the confusion between the English billion (10^{12}) vs the American billion (10^9) persisted until quite recently.**

Indian Big Number Terms

-Well established in late BC/early AD

| | | |
|------------------------|------------------------------------|-------------------------------|
| Ek (<i>one</i>) | = 1 | = 10^0 |
| 10 Ek | = 'Thus' (<i>Ten</i>) | = 10^1 |
| 10 'Thus' | = Sau (<i>Hundred</i>) | = 10^2 |
| 10 Sau | = Hazar (<i>Thousand</i>) | = 10^3 |
| 100 Hazar | = Lakh | = 10^5 |
| 100 Lakh | = Crore (<i>10 Million</i>) | = 10^7 |
| 100 Crore | = Arab (<i>Billion</i>) | = 10^9 |
| 100 Arab | = Kharab | = 10^{11} |
| 100 Kharab | = Neil (<i>10 Trillion</i>) | = 10^{13} |
| 100 Neil | = Padum | = 10^{15} |
| 100 Padum | = Sankh | = 10^{17} |
| 100 Sankh | = Maha Sankh | = 10^{19} |

Spread of Indian Numerals: Greeks Missed It

- Greeks might have picked up several mathematical ideas from the east, e.g., “Pythagoras” Theorem and trigonometry etc.**
- Note: Even before the Invasion of India by Alexander in 326 BC, there was much contact and travel between the Greek and Indian worlds. The ancient Persian Empire extended from Greece, Phoenicia and Egypt in the west to western India (modern Pakistan) in the east. Under the Persian Empire, the Greeks had large settlements in the east, e.g., Bactria (northern Afghanistan). Hence, the Persian Empire, the first great ‘world power’, was a great melting pot, which facilitated cross-fertilization of ideas.**
- However, the Greeks missed the invention of Indian zero and the base-10 place value system.**
- After the disintegration of Alexander’s empire the contact between the Greek and Indian worlds was lost for many centuries.**

Arrival in Arabia

- Al-Khwarizmi (680-750 AD) of 'algorithm' and 'algebra' fame, was a Persian mathematician who worked in the House of Wisdom (research institute), Baghdad, established by the Abbasid Caliph Mamun Rashid (son of Harun Rashid of 1001 Nights fame).

-Wrote the famous book on Algebra: Hisab al-Jabr w'al-Muqabala

⇒ Word 'algebra' derives from this book.

-Wrote other book: The Book on Addition and Subtraction by Indian Methods (original lost, exists in translations). This book introduced Indian numerals to the Arab World

- Gave algorithms for basic arithmetic operations, using base-10 Indian numerals.

- Note: The word 'algorithm' is a corruption of the surname 'khwārizm'.

Arrival in Europe

- **Arabs call them Indian numerals**
- **Europeans called them Arabic numerals**
 - ⇒ **Hence, the modern compromise: “Hindu-Arabic Numerals”**

- **Arabic Spain was already using Indian numerals after its introduction in the Arab World by Al-Khwarizmi in the 8th century AD.**

- **Western Europeans studying in Arab universities in Spain were slowly carrying the idea of ‘Arabic’ numerals back home.**

- **Leonardo de Pisa (Fibonacci) (1170 – 1250 AD), born in present day Algeria, was the first great European mathematician of the medieval period.**

- **Also famous for his work on ‘Fibonacci Sequence’ and ‘golden ratio’ etc.**

- **Had Arab teachers, traveled to Syria etc. Eventually, settled back in his native Italy.**

- **Introduced Arabic Numerals to Europe in his book, *Liber Abaci* (Free of Abacus), in 1202 AD.**

- **‘Arabic’ numerals strongly resisted by the Church and universities as the numbers of the infidels.**

- **Merchants kept secret records in ‘Arabic’ numerals because they found them much easier.**

- **Unofficial ‘Reckoning Schools’ sprang up in Italy in the 15th AD, which taught calculation using ‘Arabic’ numerals. Teresi (p. 25) calls it “bootlegging” in Indian numerals.**

- Unemployed mathematicians used to make money by entertaining crowds, making apparently, impossibly large calculations using Arabic numerals. (Teresi)

- Abicists vs Algorists: The debate went on for a long time. Eventually algorists won.

Abicists: Calculation using Roman numerals was difficult. Arithmetic was a difficult discipline. Required experts using abacus. Their argument: Keep using abacus. Much cheaper. Arabic numerals require paper, which is expensive. Besides, Arabic numerals are the symbols of infidels (Of course, the ‘abicist’ experts would also keep their power and importance if the calculations remain difficult).

Algorists: The word is a corruption of ‘Al-Khwarists’. Their argument: Use Arabic numerals, and do calculations ‘al-khwarist’ way. It is much simpler and does not need abacus. Also, abacus is not good for record keeping. Writing the calculations down on a paper is much better record keeping. Besides, paper is getting cheaper, anyway.

-German Merchant’s Story:

“A German merchant of the fifteenth century asked an eminent professor where he should send his son for a good business education. The professor responded that German universities would be sufficient to teach the boy addition and subtraction but he would have to go to Italy to learn multiplication and division.”

(Beyond Numeracy by J.A.Paulos, p 15)

- 16 th century: Arabic numerals widely adopted in Europe.

⇒ Followed by great developments in math and science!

All That Fuss About Zero

Kha, Sunya→Sifr→Cipher, Zephirum

- ‘Zero and the nine numerals’: For quite some time the Europeans did not regard zero, itself, as a numeral.

- Is zero itself a number? Indians had already recognized zero as a full-fledged number in early AD, and were studying its special mathematical properties.

- Divine or Diabolical?

- Ancient Maya people of Central America had several cults around the concept of zero. Their symbols of dots and bars are very simple and practical. But they wrote zero in a very stylized form and had several versions.

- “Maya”: (East) Indian concept of illusion, nothingness
– The world is ‘maya’, i.e., the world is an illusion.

- Buddhist: Sunyata, Sunya, Nothingness. The universe came out of nothingness. A lot has been written about the supposed relationship between the origin of zero and the Indian/Buddhist concept of ‘nothingness’!

- Fear of Nothingness

- Greek fear: An imperfect number?

-Plato's numbers: Greeks idealized numbers, as existing in a pure, perfect, 'Platonic' world, independent of all the other existence. If God created numbers, why did he create zero, nothingness? It did not make any sense to the Greek philosophers.

-Pythagoras' story: A student, probably, one who had been to Mesopotamia, showed him the symbol for zero. Pythagoras got very upset. He knocked over the sand table on which he was doing calculations. Asked the students present at the time to take an oath of secrecy and to keep the idea of zero to themselves.

- Church's fear: A diabolical, Satanic symbol!

- 'Dabbling in Nothingness' could have serious consequences:

"In A.D. 967, the monk Gerbert, who would become Pope Sylvester II, fashioned a zero sign for one of the counters on his counting board. For dabbling in nothingness, Gerbert was accused of having intercourse with evil spirits."

(Lost Discoveries by D. Teresi, p 82)

Religion, Mythologies, World-Views

- **Does the numeracy level of a culture affect its religion, mythologies, world-views?**
- **All cultures have creation myths, describing how and when the world was created.**
- **The sophistication of those myths depend on the knowledge, literacy, as well as, the *numeracy* levels of those cultures.**
- **Of course, a tribe whose counting is restricted to, ‘one, two, many’, won’t be able to describe the age of the world in hundreds of years, because they do not have any terms for such numbers.**
- **Christian creation: 7-8000 years BP.**
- **Sir Isaac Newton also worked on the ‘age of the universe’ and tried to come with a ‘more accurate value’ based on his interpretation of the Bible.**
- **Until 19th century educated people were seriously calculating more and more ‘exact’ dates of the creation based on the Bible (right up to day, date, month, year etc!) – all around 7-8000 years BP.**
- **Even now many fundamentalists believe that to be the true age of the universe.**
- **Bible and Quran do not mention any number term bigger than thousand (or ten thousand in Bible?). The religious myths of Judaism, Christianity and Islam crystallized in a period of generally low numeracy level. Terminology for bigger numbers**

did not exist in Ancient Arabian, Hebrew and European cultures. Numeracy level was low because they did not have access to an advanced place value based number system, with a zero.

- Ancient Hindus and Mayas had much higher numeracy levels. With their invention of zero and advanced place value based number systems they were quite comfortable with large numbers. Hence, they used large numbers generously and abundantly in their mythologies.

- Hindu universe: hundreds of billions of years old (Present cycle started: 4.3 b.y. BP).

- Maya creation: 2×10^{27} years BP!!!

- There is a strong resistance to the theory of evolution in the 'western' religions – Judaism, Christianity and Islam.

- A large number of American states, for example, place some kind of restriction on the teaching of the theory of evolution. It is a big issue in the USA.

- There is no such resistance to the theory of evolution in the eastern religions – Hinduism, Buddhism etc. It is not an issue, at all.

- Why?

- There might be many reasons. But here, I am concerned with one: the numeracy level of the cultures where these religions started.

- A small age of the universe (in thousands) places a severe restraint on any explanation of the variety and multitudes of

living creatures (and on geological forms and processes too, for that matter).

- Because of the very small age of the universe in the western religions, it is hard to accept evolution, which takes place on a time-scale of millions of years.

- Would evolution be more acceptable if the earth was older?

- The large age of the universe in the eastern religions is much closer to reality.

- Modern astronomical age of the universe is about 15 billion years

- The age of the Earth is about 4.6 billion years

⇒ It is much easier for the eastern religions to accept the slow, natural processes of geological and biological evolution.

- 8000 years ~ 400 human generations.

⇒ Hard to accept that man could have evolved out of the primates, let alone single-cell creatures, in only 400 generations.

- 4 billion years ~ 200 million human generations.

⇒ Hard to believe that we would have kept the same form in 200 million generations. Hard not to accept evolution.

Bibliography

Barrow, John D., *Pi in the Sky* (Back Bay Books, 1992)

Blanter, David, *The Joy of π* (Penguin, 1997)

Clegg, Brian, *A Brief History of Infinity* (Constable and Robinson, 2003)

Coulter, Laurie, *Secrets in Stone – All About Maya Hieroglyphs* (Madison Press, 2001)

Danielo, Alain, *A Brief History of India* (Inner Traditions, 2003)

Devlin, Keith, *The Math Gene* (Basic Books, 2000)

Kaplan, Robert, *The Nothing That Is – A Natural History of Zero* (Oxford U.P., 1999)

McLeish, John, *The Story of Numbers* (Ballantine Books, 1991)

Miller, C.D., Heeren, V.E., and Hornsby Jr, E.J., *Mathematical Ideas, 6th Ed.* (Harper Collins, 1990)

National Geographic Society, *National Geographic Atlas of the World, 7th Ed.* (National Geographic Society, 200?)

Paulos, J.A., *Beyond Numeracy* (Random House, 1991)

Teresi, Dick, *Lost Discoveries* (Simon and Schuster, 2002)