THE NEW MILLENNIUM

An arbitrary event in history

by

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With the approach of the year 2000 we hear a lot of talk about the significance of rolling over the calendar. Apocalyptic theories abound, with alleged causes ranging from the second coming of Christ to a Y2K meltdown. I leave the former to the Bible scholars and the latter to the computer programmers. Instead, I'd like to look at the secular (and non-computer) significance of the impending calendrical change.

WHAT IS THE MILLENNIUM?

Definition

According to Webster's II New Riverside Dictionary (1984, Berkley Books, New York):

mil·len·ni·um (mĭ lĕn′ ē əm) *n., pl.* **-ums** *or* **-ni·a** (-ē ə). **1.** A period of 1,000 years. **2.** The 1,000-year reign of Christ on earth mentioned in the New Testament. **3.** A period of prosperity, happiness, justice, and peace. **-mil·len′·ni·al** *adj.*

(Yes, there are TWO n's.)

I think we can eliminate definitions (2) and (3) as the millennium just ending, and if either represents the one about to begin then "Hooray!" As for the ending millennium, we are left to contemplate the first definition–an unspecified period of 1,000 years.

WHY 1,000 YEARS?

Natural Cycles

So why is 1,000 years a significant time period?

We reckon time from Nature's own cycles. The day is based on the repeating pattern of light and dark caused by the sun's apparent motion through the sky (but actually caused by the earth's rotation). The year is based on the repeating pattern of the seasons which results from a combination of the earth's orbital motion around the sun and the tilt of its equator relative to that orbit. Even the month has its roots in the repeating pattern of the moon's phases as it circles the earth showing us first its lighted side and then its dark side.

So where in this complex dance of sun, moon, and earth is the cycle that repeats with a 1,000-year period? None exists. The 1,000-year cycle is a man-made construction. We have to look to ourselves to find its significance.

A Whole Lot of Nothing

We are simply fascinated by numbers that end in one or several zeroes. Consider your age. For the first few years of a human's life, every single birthday is considered significant. You can buy birthday cards that say "Look Who's 1!", "Look Who's 2!", and so on up to 6, 8 or 10. After that, the significant birthdays are usually tied to societal privileges–at 16 you get your driver's license (in most states), at 18 you can vote, at 21 you can buy liquor (ahem!). From there, it's the decade years that we most take note of. Once again you see birthday notices in the paper, on the local access cable channels, and you can buy birthday cards with "Look Who's 30!", "Look Who's 40!" and so on. For a while we dread these rollover years–years when we have to rollover another digit in the second column of our age. I suspect that at some point, if we don't quite welcome these birthdays, we are at least relieved to see them. And the next big one comes when you roll over that third digit–100, a centenarian, entitling you to "Happy Birthday" cards from former presidents and best wishes from Willard Scott.

How many of us noted when our cars rolled over first 1,000, then 10,000, and then 100,000 miles (depending on when you bought it and if you kept it that long). I know exactly where I was and who was in the car when the latter happened for me. Why is Wilt Chamberlain's 100 points in a single game of basketball so famous? Okay, even 96 points would be famous too, but 100 is so much more satisfying. On TV, shows that reach their 100'th episode will congratulate themselves and often have retrospectives to celebrate. Did you note the celebration on the floor of the New York Stock Exchange the first time the Dow Jones Industrial Index closed over 10,000? The list goes on and on.

We like numbers that end in zeroes. Somehow, they seem significant because we are turning over a never-before seen number in the leftmost column of digits. Isn't that enough? Maybe Nature likes this type of signpost. Maybe there's still some natural significance that makes these numbers more important.

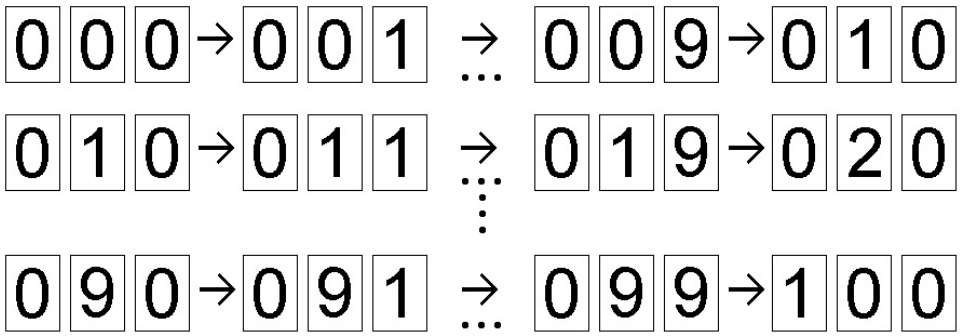
Ten Fingers, Ten Toes

If you're of the right age, you may remember new math,–the term if not the actual subject matter. One of the things often taught in this approach to mathematics was the difference in "numbers" and "numerals." The former describes an actual count of objects–how many fingers on two hands, how many apples in the basket, how many months in a year. The latter is our way of signifying that number–our written and oral expression used to communicate the idea of how many fingers on two hands and so forth.

A similar analogy can be drawn from language. A table (the object) is what it is (and that's all it is). However, the word we use to describe it varies from one language to another. A "table" in the U.S. is a "mesa" in Mexico. The same is true of descriptions. The table is "white", but the mesa is "blanca." One table, many ways to signify it.

So how else could we describe our ten fingers on two hands? Roman numerals? Well, yes. But for more rigorous mathematical options, we look at different bases or systems of counting.

Base 10 is the numbering system we use for most things. We have ten symbols, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9, and our description of any number can be made using an appropriate combination of this "numerical alphabet." (In the same way, we can write any word in the English language using the appropriate combination of the 26 letters of the English alphabet.) The rules for assigning a numeral (the numerical equivalent of a properly spelled word) to a number are straightforward. Starting with 0 to represent none, we increment the digits sequentially one at a time until we've used all ten (when we've reached the number 9). Then, as on a scoreboard, the next increment takes us back to 0. We now increment a second column of digits from 0 to 1 to show that we've been through the rightmost column one time. This gives us the numeral 10. A second trip through the rightmost column brings us to 19, and a single increment from there requires stepping up the second column once again so we have 20. After nine complete trips in the rightmost column we are at 90. One more cycle, and we've run out of digits in the second column. We now increment the third column from 0 to 1 giving us 100. And so it goes.



Incrementing a scoreboard in Base 10.

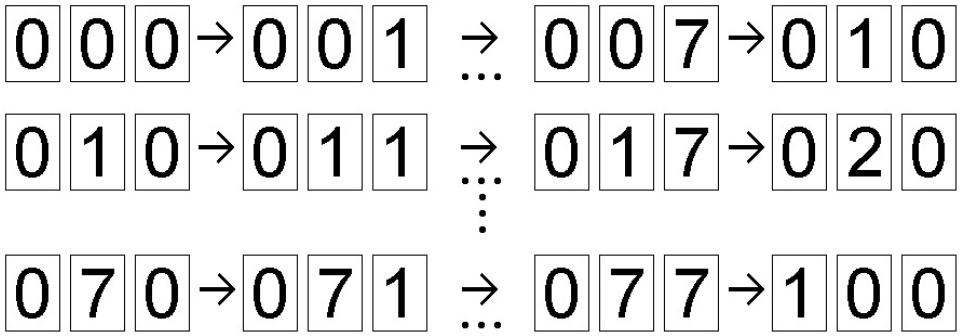
But why ten symbols?

While there is no definitive answer to this question, the most likely answer is "We have ten fingers." Somewhere back there one of our ancestors used her fingers to count some collection of important objects. When she ran out of fingers, she made a mark on the ground and then repeated the process. While Nature had no preference for base 10 in the heavens, She seemed to have one for humans. Or did She?

Most anthropologists and biologists would agree that base 10 is not the only or even the obvious choice. What if our great-many-times-over-grandmother had used only one hand because she was holding her baby with the other? The result would be base 5. Or perhaps she would have distinguished between her thumbs and the other fingers. Base 8 results. Or she could have used all her fingers and her toes before repeating the cycle: base 20. In fact, the Mayans used base 20 for their calendars, counting out twenty-day cycles (among others) in a complex pattern that cannot be immediately matched to the days, weeks, months, and years with which we are familiar.

How might the approaching year be signified if we were using one of these other bases? Let's consider base 8–a counting base familiar to computer programmers. In base 8 we have only 8

symbols, 0 through 7. So when we reach the number 8_{10} (read as "eight base ten, the subscript represents the base, or numerical language, being used) we have to increment the second column in base 8, and the numeral representing eight objects is 10_8 (ten base eight, still equal to the number of "non-thumb" digits most of us have on two hands). Continuing to count through our symbols, the base-10 numeral 15_{10} represents the same number as the base-8 numeral 17_8, and the next number can be represented as either 16_{10} or 20_8. We only get eight cycles in base 8, so 64_{10} is 100_8 and so forth.



Incrementing a scoreboard in Base 8.

By the time we reach the base-10 numeral 2000_{10}, we are using the numeral 3720_8 in base 8. While is does end in zero, it hardly has the impact of the three zeros on the numeral 2000. A few other examples are:

Representation of the number 2000 in various bases	
Base 5	31,000
Base 8	3720
Base 10	2000
Base 12	11A8*
Base 16	7D0*
Base 20	500

**In bases greater than 10, more than ten symbols are required. It is customary to use the letters of the alphabet to represent the additional numerical symbols. For example, base 16 uses the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F.*

There are some zeros at the ends because 2000 is divisible by 5, 8, 10, 16, and 20, but we can see that the number of trailing zeros varies with each base and only bases 5 and 10 mark next year as millennial.

1,000 YEARS SINCE WHEN?

New Beginnings, Old Endings

Okay. Nature has no 1000-year cycles, but we like lots of zeros. The number of trailing zeros depends on the counting base used to describe a number, but we have for some reason settled on base 10. Given these conditions, next year is labeled 2000–three zeros, a millennial turning point. Or is it?

Let's go back to the definition of millennium.

mil·len·ni·um (mĭ lĕn′ ē əm) *n., pl.* **-ums** *or* **-ni·a** (-ē ə). **1.** A period of 1,000 years. **2.** The 1,000-year reign of Christ on earth mentioned in the New Testament. **3.** A period of prosperity, happiness, justice, and peace. **-mil·len′·ni·al** *adj.*

None of these definitions is directly tied to our labeling of years–our calendar. Next year is 2000 A.D. (*Anno Domini*–the year of our Lord). It implies 2000 years since something, but what? If a new millennium is beginning, an old one must be ending. What marked the beginning of the current millennium? Or the one before that?

This one seems obvious. At least in Christian society, we all "know" that we mean "2000 years since the birth of Christ," right? Of course Christ was actually born on December 25, so December 25, 1999, is really His 2000'th birthday, but what's a week out of 2000 years?

Well, what's "obvious" is not always what's "right." Read properly, the upcoming year reads "in the 2000th year of our Lord." That is to say, we will be entering year number 2000, having just finished 1999 years since Christ's birth. You see, our current way of counting years dates back to a Sixth-Century cleric named Dionysius Exigusus (Denis the Little) who was assigned the duty of determining the dates for Easter. *(The calculation of Easter dates is not a straightforward one. It involves such astronomical events as the Vernal Equinox–the first day of spring–and the first full moon following the Vernal Equinox–the "Paschal Moon." In days before computers and good working models of the solar system motions, these dates were determined through a series of mathematical formulas which had been developed over the centuries. The duty of determining these dates in advance belonged to the clergy.)*

Dionysius had an existing table of Easter dates for the years 228-247 *Anni Diocletiani*–years since the beginning of the reign of the Roman emperor Diocletian.[1] *(This was a common way of counting years in many societies, starting from the ascension of a prominent ruler and running until someone more impressive, more powerful, or more popular, took the throne.)* So Dionysius needed to begin his table with the year 248 *Anno Diocletiani*. However, he did not wish "to perpetuate the memory of an impious persecutor of the Church. He preferred to count and denote the years from the Incarnation of our Lord Jesus Christ."[2] Dionysius' methods are not known, but he fixed the date of Christ's birth to December 25 in the year 753 AUC (*ab urbe condita*–since the founding of the city, Rome to be specific).[1] He then "restarted" his reckoning of time on January 1, 754 AUC–the eighth day after Christ's birth and the day of the feast of

circumcision (and probably not coincidentally New Year's Day in Roman and Latin Christian Calendars).[3] Now, since 248 *Anno Diocletiani* corresponded to 1285 AUC, Dionysius labeled it 532 A.D., *Anno Domini Nostri Jesu Christi*, the 532nd year of our Lord Jesus Christ.[4]

So what's wrong here? By most reckoning methods, we begin counting the age of something (humans, automobiles, whatever) at 0. Then, after one year of existence we label them as one year old. However, Dionysius had no concept of the number zero. The Romans didn't use it, and it wasn't introduced to modern mathematics until the late eighth or early ninth century, and that was done by Hindu and Arabic mathematicians. The concept wasn't exported to the West until around the end of the first millennium. *(The Egyptians had used zero sporadically, and the Chinese implied the concept with their abacus but had no symbol for it. The Mayans used zero, but they were, of course, unknown to Dionysius.)*[3] So Dionysius began at 1 A.D., when Christ was just an infant, and by the time Jesus celebrated His first birthday, Dionysius' calendar would have been turning over to the year 2. Following this cycle through to current times, we see that Christ's 2000th birthday occurs not on December 25, 1999 A.D., but on December 25, 2000 A.D., more than a year from now, and January 1, 2000 A.D. harkens in not the beginning of the third millennium since Christ's birth, but the last year of the second millennium. And so the purist will argue that the new millennium begins on January 1, 2001 A.D. despite all the pomp and celebration that will inevitably surround the change from 1999 to 2000.

This is the position taken by most "official" timekeepers around the world. The U.S. Naval Observatory, charged with maintaining the Master Clock for the U.S., is maintaining a countdown of days "to the year 2000" and a separate countdown "to the next millennium" on their home page.[5] The Royal Observatory in Greenwich, England, timekeeper for the world[6] and the National Institute of Standards and Technology (NIST)[7], keepers of the atomic clocks for the U.S. also state for the record that the new millennium will begin on January 1, 2001 A.D. Even the White House[8] (using the USNO as its information source) agrees.

Of course, all of these sources realize that official pronouncements will not stop the parties this year. After all, USNO is counting days to the year 2000. Greenwich, England (the city) is planning what appears to be a year-long celebration. I'm sure you've already heard of "millennium cruises" and other commercial ventures to "celebrate the millennium" (celebrating "early" certainly won't hurt their pocketbooks). *USA Today* reported on September 22, 1999, that Boston has decided to push the millennium even earlier–celebrating the beginning of the new "millennium" at 7 p.m. EST on December 31, 1999, which corresponds to midnight Greenwich Mean Time.[9]

Denis' Other Error

Now we've decided to accept our arbitrary but human definition of 1000-year cycles, and we've set our reference point to the birth of Christ. The new millennium begins on January 1, 2001 A.D., although most of us will celebrate a year early. Right? Well...

It turns out that in addition to missing out on the year 0, Dionysius probably also made a mistake in his placement of Christ's birth in the historical records. Matthew 2:1 says "After Jesus had

been born at Bethlehem in Judea during the reign of King Herod, there arrived wise men at Jerusalem from the east." Matthew describes the fear and anger of Herod at the prospect of a new king and Joseph and Mary's flight from Israel with their young child. Then in Matthew 2:19, "But upon Herod's death an angel of the Lord appeared in a dream to Joseph in Egypt," and from there we learn of the family's return to Israel to settle in Nazareth.[10]

Clearly the Bible indicates that Herod's death occurred some time after Christ's birth. Historians have placed Herod the Great's death somewhere around 4 B.C.–more than three years before Dionysius' date of December 25, 1 B.C. for Christ's birth. Many historians now place Christ's birth as likely occurring in the year 7 B.C., some six years early than reckoned by Dionysius. *(Stephen Gould, renowned Harvard natrualist, expresses some amusement at the prospect that Christ was born Before Christ.)*

So we now must decide whether to use the calendar date or the historical date for Christ's birth as our zero point. Our decision carries a few implications. To choose the former is at least tidy. The calendar dates have some kind of meaning even in light of Dionysius' missing year zero, and we have the prospect of celebrating an upcoming millennial change. However, if we are to trust the historians (and try to have at least one non-arbitrary term in our definition of the new millennium), we are faced with the disappointment of having missed the chance for a timely party. If Christ's birth occurred in 7 B.C., the 2000'th anniversary of his birth passed by quite unnoticed in December of 1994, and the "new" millennium is already well underway.

ACCORDING TO WHOM?

The Gregorian Calendar

The calendar used by most Americans and European, and for international civil purposes is the Gregorian calendar. It is a solar calendar, which means it reckons years based solely on the cycle of the seasons. In early Rome, a 365-day calendar incorporating twelve 30-day months with five unassigned festival days was employed. Since the seasons cycle with a period that is actually 365.2422 days, the calendar cycled faster than the seasons. Thus, the Vernal occurred ever so slightly later in each successive year. Julius Caesar asked his astronomers to devise a solution that would hold the equinox, and thus the seasons, to a fixed point in the calendar year. The result was the Julian calendar, a 12-month calendar with 365 days for three consecutive years followed by a 366-day leap year every fourth year.

The average year on the Julian calendar is 365.25 days, just 0.0078 days or 11 minutes 14 seconds longer than nature's year. While this may seem small compared to the length of a year, it does accumulate an error of about one day every 128 years. By the 16th Century, the Vernal Equinox had drifted earlier in the calendar year to March 11. Since the date of the vernal equinox is assumed to be March 21 in the calculation of the dates of Easter (as established by the Council of Nicea in 325 A.D.), this presented a serious problem to the Roman Catholic Church. Pope Paul III commissioned a panel to once again find a solution to the calendar problem. The final suggestions were not available until after his death, so it was Pope Gregory XIII who issued

the papal bull defining what is now known as the Gregorian calendar. Essentially, the Julian calendar was kept with the modification that years divisible by four continue to be leap years with 366 days EXCEPT if the year is also divisible by 100. Years divisible by 100 but not by 400 are not leap years. The average length of a year in the Gregorian system is 365.2425 days, just 0.0003 day (8.64 seconds) too long, which means it is accurate to one day every 3333 years.[4,]

The Gregorian calendar maintained Dionysius' reckoning of years, and it is the apparent turning of a millennium on the Gregorian calendar which we are about to celebrate.

The Julian Calendar

Use of the Gregorian Calendar is not universal even in the Western world. The Orthodox Church (Eastern Orthodox) continues to use the Julian Calendar to calculate the dates of feasts and holidays. The use is uneven–some portions of the Church use the Julian only for moveable feasts (which are not fixed to a particular day on the calendar, such as Easter). Some now use the "Revised" Julian, which has been adjusted to match the current Gregorian dates but will continue to include leap years every four years without the century exceptions included in the Gregorian Calendar.

The Hebrew Calendar

The Hebrew calendar is the official calendar of Israel and the liturgical calendar of the Jewish faith. It is a lunisolar calendar, incorporating both lunar and seasonal cycles in the reckoning of years. Months begin on the day of a tabulated new moon and last for 29 or 30 days. Years consist of twelve or thirteen of months with twelve ordinary years of twelve months and seven leap years of thirteen months repeating in a nineteen-year cycle. The first day of the year is 1 Tishri which corresponds to the Jewish holiday Rosh Hashanah, celebration of the creation of the Earth. Years are reckoned from the Era of Creation which is considered to be October 7, 3761 B.C. on the Julian calendar[4] *(September 8, 3761 B.C. Gregorian*). On January 1, 2000 A.D. (Gregorian), the Jewish year will be A.M. 5760 (*Anno Mundi*, years since creation).[6]

The Islamic Calendar

The Islamic calendar is a purely lunar calendar with twelve months to the year. Each month begins with the sighting of the new crescent moon (locally or by an authority in the Muslim world–rules and practices vary from one country to another and from one religious leader to another). A crude civil calendar is approximated using tabulated dates of when the early crescent moon should be visible, but the official calendar depends on human sightings. Since the lunar cycle is approximately 29.5 days, each year contains only 354 days, with occasional 355-day leap years. Thus the Islamic calendar regresses through the seasons in a 32-33 year cycle.

Years are reckoned from the Era of the Hijra commemorating the migration of the Prophet from Mecca to Medina. Chronologists place this initial epoch 1 A.H. (*Anno Higerae*) Muharram 1 (Muharram is the first month) at July 15, 622 A.D. Julian (*July 17, 622 A.D. Gregorian*). On

January 1, 2000 A.D. (Gregorian) the Muslim year will be 1420 A.H. (Note that Islamic years accumulate faster since they average 11 days less per year than the Gregorian calendar.)[1, 4, 6]

The Chinese Calendar

Although the People's Republic of China uses the Gregorian calendar for civil purposes, the Chinese Calendar is still used to set the dates of festivals. It is a lunisolar calendar in which the first day of the month occurs on the day of the astronomical new moon. Ordinary years have twelve months, and leap years have thirteen months. Leap years occur when there are thirteen new moons between the months containing the winter solstice in consecutive years. Years are counted in a 60-year cycle by combing ten "celestial stems" in sequence with twelve "terrestrial branches." (*It is the twelve terrestrial branches that represent the Chinese zodiac–rat, ox, tiger, hare, dragon, snake, horse, sheep, monkey, rooster, dog, and pig.*) The practice of counting years from the ascension of the emperor was abolished after the 1911 revolution. There is no current method of counting years sequentially, although the cycles of 60 years are labeled beginning with cycle one in the year 2637 B.C., the year the calendar was invented according to Chinese legend. The current cycle began on February 2, 1984 (Gregorian). We are currently in the 16th year of the 78th cycle. If these years were counted sequentially, January 1, 2000 A.D. (Gregorian) would occur in the year 4636 (Chinese).[1, 6]

The Indian Calendar

Since a calendar reform in 1957, India uses a lunisolar calendar which remains in sync with the Gregorian calendar for civil purposes. Although Indian months are offset from those of the Gregorian calendar, leap years occur in the same years. The religious calendar uses a mixture of lunar months which begin with the new moon (or with the full moon in some regions) and solar months which are based on the sun's position. Although the India Meteorological Department tabulates date for religious purposes, a wide range of local variations are still used.

Years in India are reckoned for the Saka Era which began with the vernal equinox in 79 A.D. Thus January 1, 2000 A.D. (Gregorian) will occur in 1921 S.E.[4, 6]

The Mayan Calendar

The Mayan calendar actually incorporated three independent cycles: the Long Count which cycles every 1,872,000 days (about 5125 years), the Tzolkin which cycles 260 days (the product of a 13-day cycle and a 20-day cycle), and the Haab which cycles every 365 days (18 "months" of 20 days each, followed by 5 extra days). The latter two cycles were not counted, so only the Long Count involves a year count.

The Long Count includes five separate elements, each indicated by a number. The smallest element is rightmost in the list and completes a cycle before the next element in incremented. The elements, from smallest to largest are the kin or day (numbered 0 to 19), the unial (numbered 0 to 17), the tun (numbered 0 to 19), the katun (numbered 0 to 19), and the baktun (numbered 1 to 13). The cycle begins with 13.0.0.0.0, 13.0.0.0.1, 13.0.0.0.2, ...to 13.19.19.17.19 and then

repeats. Authorities disagree as to when the most recent cycle began, either August 11 or 13, 3114 B.C. (Gregorian) or October 15, 3374 B.C. (Gregorian).[11]

Based on the first two possibilities, the next cycle will begin with 13.0.0.0.0 on December 21 or 23, 2012 A.D. (and this is even bigger than a millennium!).[1]

IN SUMMARY

So New Year's Day 2000 A.D. will occur in the calendar years shown below:

Calendar	Year	Initial Epoch
Gregorian	2000 A.D.	*Anno Domini*
Hebrew	5760 A.M.	*Anno Mundi*
Islamic	1420 A.H.	*Anno Higerae*
Chinese	4636	
Indian	1921 S.E.	Saki Era

Of course the years will be different for January 1, 2001 A.D., but the point is made. Only the Gregorian calendar has a millennial boundary approaching anytime soon. And even if one chooses to use the Gregorian calendar and the birth of Christ as the initial epoch for determining millennial periods, we have seen that there is indeed some confusion and disagreement on the precise placement of that event.

So now what? Enjoy the party. After all, even our choice of New Year's Day is arbitrary, and that hasn't stopped us from placing all kinds of significance on that day–new tax years, new year's babies, New Year's Eve celebrations, and so on. So why shouldn't our choice of which New Year's to celebrate a bit harder be just as arbitrary? If you decide that December 31, 1999 A.D. is the one, have fun! You can always change your mind later and decide that the old millennium ends on December 31, 2000 A.D. And if you that's not enough, there's always the start of a new Long Count in a few years...

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