Leaping toward the end of the millenium

If this year, the last one of the millennium, seems a bit longer, there's a good reason. The year 2000 is a leap year. Consequently, we'll tack an extra day on to February to stretch the month to 29 days and the year to 366 days. This additional day is needed because the orbital period of the Earth, the time it takes to make one revolution around the Sun, is not an even number of days. This was recognized during the time of Julius Caesar. By his decree in 46 B.C., an extra day was added to the Julian calendar year every four years to synchronize the calendar year with the Earth's orbital period. This seemed more convenient than lopping off a quarter day each year for three years and then adding them back together during the fourth year.

The Julian calendar, as designed, was used for the next 16 centuries. Interestingly, during the 7th century a monk known as the Venerable Bede made some calculations suggesting that the Julian calendar was too long by approximately 12 minutes, or was losing about one day every 128 years, or 3 days nearly every 400 years. In other words, the Julian calendar was not accurately synchronized with the Earth's orbital period around the Sun, and calendar events had the potential for occurring earlier than scheduled. Unfortunately, nothing was done about this until several more centuries had passed and the lack of synchronization had led to a 10-day discrepancy between the calendar year and the Earth's orbital period around the Sun.

In 1582, Pope Gregory XIII recognized the seriousness of letting the calendar year continue to fall behind. In order to address this discrepancy, Pope Gregory XIII decreed that *any* year divisible by 4 would be a leap year, unless that year were a century year, in which case it would also have to be divisible by 400. (The year 2000 is a leap year and a leap century and is the first leap century since 1600.) While this correction would obviously help align future calendars, the only way to bring the present calendar back into sync was to remove 11 days. So, during October of 1582, the calendar skipped from October 4 to October 15.

Losing track of time

There are several reasons why our calendar gets out of sync with the Earth's orbital period. The first complication is that we use days as our measuring rate. When we talk about a day, we are referring to the mean solar day, or 24-hour period it takes for the Earth to complete one rotation. However, the actual time it takes for the Earth to complete one rotation is 23 hours, 56 minutes, and 4 seconds, which is referred to as the sidereal day.

Further complicating matters is that the 365.25-day period we use to calculate leap years is also an approximation. The actual orbital period of the Earth around the Sun is 365.2422 days, which is known as the tropical or seasonal year. The tropical year begins when the Sun is at a specific equinox point and ends when the Sun returns to that equinox point. For example, at the equinox position in March, the Sun has an astronomical coordinate position of 0 hours and 0 degrees. During the following year, the Sun appears to move eastward following a path known as the ecliptic. After 365.2422 days of Earth revolution, the Sun appears to return to the position of 0 hours and 0 degrees.

In Caesar's time, the approximation of a year, 365.25 days, was based on the Earth's motion relative to the "fixed" stars in the background. This sidereal year is actually 365.2564 days in length, which accounts for the timekeeping troubles.

Online resources

Leap Year Calculation Formula: *www.asiaonline.net.hk/~tfwong/leapyear.htm*
Online Leap Year Calculator: *www.enter.net/~alouie/leapyear.htm*
St. Bede the Venerable: *www.micds.pvt.k12.mo.us/stud_fac/faculty/jhoughto/medstud/Bede.htm*
Bede.net: *www.geocities.com/Paris/Musee/3206/Welcome.html*

Bob Riddle *teaches sixth grade science at Southwest Charter School in Kansas City, Missouri. Email him at* starwalk@currentsky.com *or visit his website at* currentsky.com.