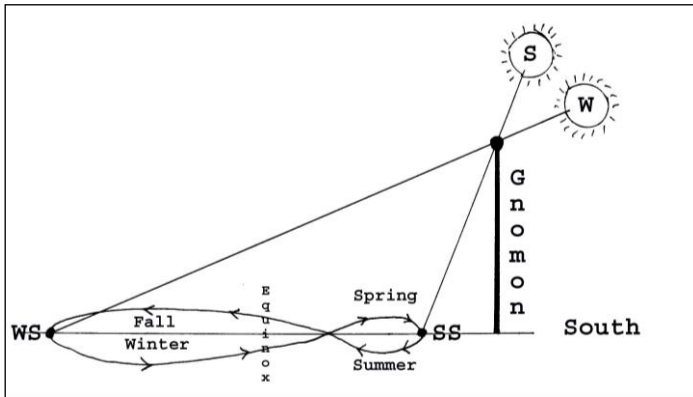


# Walking an Analemma

Marc Stowbridge

If you plot a shadow cast by the top of a pole (called a gnomon) at noon over the course of a year, you will form a figure-8 called an *Analemma*. This is a good tool for teaching about how the Earth and Sun interact to make seasons.



The Summer Sun looms high in the diagram above, and the Winter Sun is low, casting a long shadow.

Because the Earth's axis is tilted and has an elliptical orbit, the Sun's altitude at noon changes throughout the year and moves slightly east and west. One effect of this change is that simple sundials can't be taken at face value when compared to "clock time". A sundial shows the "apparent solar time" while clocks indicate "mean (average) solar time." The difference between the two is called the "equation of time," and can add or subtract minutes to the sun dial time, depending on the time of year. The distance left or right from the long-axis centerline of the Analemma indicates the direction and amount of this difference. (In the diagram above: Fall & Spring are ahead, while Winter and Summer are behind clock time.)

Schools and other public buildings usually have some open space available, and I thought of using such a place to build a long pathway that followed the figure 8 of an analemma. This path would be marked at weekly intervals or so, based on the shadow of a post set high in the south. People could walk the analemma, rather like a medieval meditation labyrinth. At each step, the traveler can stop and look how the angle to the gnomon has changed. They would see how the winter is stretched with long shadows, and how the summer sun looms high overhead. Even the spacing of the days: close together in summer, and requiring long strides in winter might help them understand the process. One could label the points on the ground corresponding to the solstices and equinoxes.

The trick is setting it up. You can simply mark the position of the gnomon's shadow once a week at noon, and in a year, you will be done. This assumes no rain, snow or vacation times. A little planning will keep your path on snow-free walkways or from bumping into things. The length of the analemma will be a bit less than two and a half times the height of the gnomon in middle latitudes like mine. This means that the gnomon for a path one could walk would need to be proportionally tall. If one set the gnomon near the edge of a high northern wall, the resulting pathway could be quite long.

If your target area is flat and level, it's possible to plot an analemma by using solar position tables and a bit of math. Being impatient, and a tinkerer, I instead decided to use my computer driven Meade Go-To telescope like a surveyor's transit to help.

To begin, I used a planetarium program to find the noon azimuth and altitude (Az/Alt) position for the Sun on dates 2 weeks apart for a year. One needs to be sure to set the site in the planetarium program for the location of your analemma and that it matches the site in the setup file of the Autostar©. Part of the data set I used at the North East Astronomical Forum is below:

Suffern, NY N 41° 7' 35" W 74° 5' 15"		
Date	Az	Alt
1/5/08	179-35	26-27
1/19/08	178-5	28-46
2/2/08	177-13	32-20

Then I loaded the date and Alt/Az data as "Landmarks" into the Meade Autostar© hand-controller. (Be sure *not* to use right ascension and declination: RA/DEC. Autostar© Landmarks are interpreted as terrestrial targets, and as such, the scope's tracking is turned off). I also entered the data for equinox and solstice

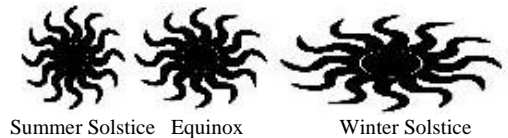
dates, as well as when the path crosses itself. You can save the file by backing up the Autostar Updater© with a new name. If you make another analemma display at a new time, or a site many miles away, you will have to enter and save a new data set.

The next step consists of getting the data on the ground. I mounted a laser on a bracket so that it shines along the optical axis of the telescope and allows the laser to clear the base when pointing to the summer solstice. When the (covered) objective lens of the telescope is pointing at the spot in the sky where the noon sun would be on a target day, the laser shines backwards to a spot corresponding to the telescope's shadow. In the picture below, the laser mounted to the back of the telescope is used to align the one on the bracket, and is then removed.



Slew to each of the *Landmark* positions and set a labeled marker on the ground at the laser's spot. Highway line paint works well on asphalt, and yellow painted 2" fender washers held by 4" nails work fine in turf. Bricks or paving tiles set at ground level make an attractive permanent walkway. This system works on uneven terrain or even up a wall, as long as the gnomon can cast a shadow along the entire path.

For displays set indoors, I illustrate the seasonal effect of the Earth's tilt by using two lasers mounted on the bracket, spaced 3 inches apart for a 3 inch gnomon's shadow. When both are turned on, the distance between the laser dots increases as the Sun lowers towards the Winter Solstice. The 3" gnomon disk casts a shadow that is about 3 1/8" in summer, 4" at the equinox, and 7" in winter. Pictures of the correct size can be placed on the analemma to show the effect after the telescope has been removed



I think it is easier to understand the chill of winter's glancing sunlight when seen this way.

When finished laying out the analemma, the telescope is replaced with a gnomon the same height as the horizontal axis of the scope. I have used a driveway reflector mounted in a box filled with cement, and I have made gnomons with copper tank floats or brass bed-knobs mounted on poles.

By the way, the analemma needn't be set up only for noon. For instance, if you would like the shadow to fall on the analemma during the 11am recess, or when the congregation is walking to their cars, simply use the desired time to get the Sun's coordinates from your planetarium software. In addition, some sites may require a different time because the analemma will only fit between obstacles or down a walkway at a certain time of the day.

This Analemma Path may not rival the Temple of the Sun or Stonehenge, but walking the double loop will let you experience the passing of time and seasons graphically and directly. The more ways we use to teach an idea, the more likely it is that we will find the right one for each student. I think you will find that walking the analemma is educational, perhaps thought provoking, and fun.

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