Student Dials

Mac Oglesby (Brattleboro VT)

During the past 2 years it was my privilege to work, as a volunteer, with children at two small Vermont elementary schools. The grade levels were 3 through 6. Together we enjoyed computer games, informal geometry, miscellaneous math activities, and building over 80 sundials.

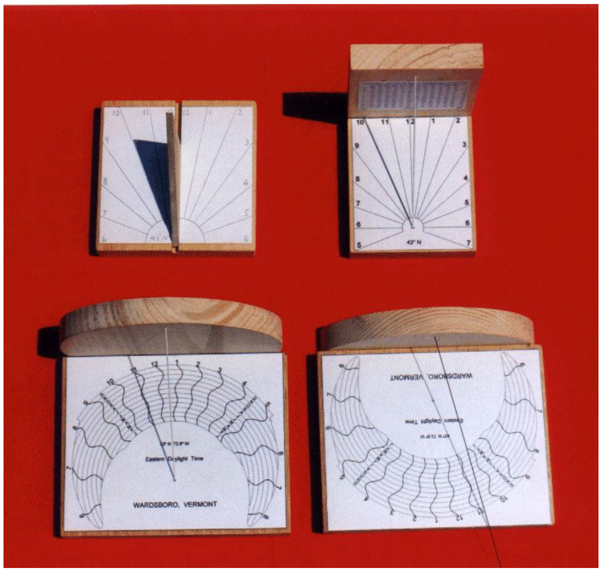

Figure 1

As a beginning project, 4th graders made 8 little sundials similar to that shown at the upper left in Figure 1. They drew the dial plates with compasses and straight edges, given xerox sheets with strategically placed dots, and glued their plates onto the wood bases. The sundial was explained, demonstrated, and tested.

Later on in that school year we made, over several sessions, about 60 sundials as shown at upper right in Figure 1. Here, the dial plates were xeroxed 4 to a sheet, cut apart, then laminated by the children, using clear vinyl shelf material, trimmed very carefully, and glued onto provided wood bases. Vertical wood backs were fastened on using a battery-powered screwdriver. (Kids of all ages LOVE power tools!) A tabletop drill press was used by the students to drill the #60 (0.040") hole for the elastic cord. My thinking was that a wire or thin rod would be easily bent but impossible to straighten. And how would you keep a string taut? Elastic cord, that's the ticket. One end was formed into a "shoelace tip" by spreading super glue onto the stretched elastic, which was then trimmed, when dry, with a razor blade. One such tip can serve for threading many dials. Knot one end, thread through dial holes, and use an alligator clip to maintain tension while forming the second knot. These dials display local apparent time but students were supplied with a table giving minutes (for every third day) to ADD to dial time to get Eastern Daylight time. The table included longitudinal offset, EoT, and a 60-minute Daylight time correction. Out-of-doors, the children positioned their sundials using clock time adjusted to local apparent time, and drew N-S or E-W reference lines for future rapid placement. On that day the basketball court was covered with 25 little sundials!

During the second school year I worked one day a week with a 4th grade class of 12 boys and one girl. Among other activities we made 18 sundials, which show Eastern Daylight time directly. See lower left dial in Figure 1. Figure 2 shows the dial plate more clearly. These dials were also created over several sessions, and followed the construction previously detailed. Notice that we made 18 dials but there were only 13 students - 4 teachers and the school's principal made dials, too. The dial plates, based on concepts I saw in articles by Gianni Ferrari (1) and by John Singleton (2), use unfolded analemmas to give standard time (in this case daylight time). An entire class period was spent learning and practicing how to read this dial.

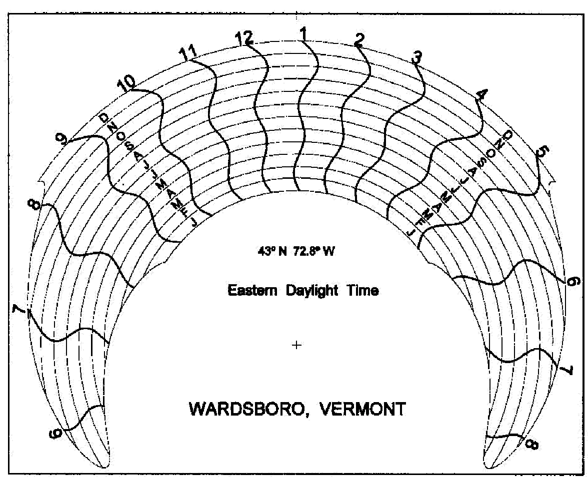

Figure 2

The dial at lower right in Figure 1 shows the same dial plate installed as a shadow plane dial. The plate was rotated 180 degrees, which allows the cord to be closer to the dial, producing a sharper shadow.

The following paragraphs were written in response to friends' questions about how to draw a standard time dial, which uses unfolded analemmas.

*** Seven Easy Steps for Designing Horizontal Plane Sundials Which Include Date Arcs and Unfolded Analemmas ***

Unless one has the mathematical skill and patience of a 20-year-old Christopher Wren, to create one of these dial plates requires a computer. I wrote a QBasic program to compute and plot the points to the screen, and to output the data to a text file, which may be converted (using Fer de Vries' CNVXXXX.EXE) to a DXF file for DeltaCad. DeltaCad 4.0 includes a Basic-like macro language, so the program steps may be written as a macro and processed directly by DeltaCad. For more information on DeltaCad macros, go to the NASS website http://sundials.org, click on Links, and look for DeltaCad Macros.

1) Obtain input for sundial location's latitude (PHI), longitude (LocLong), and time zone meridian (Meridian). For this discussion we chose Jan 1 for the innermost and outermost date arcs, but any date could have been chosen. The radius for the innermost date arc (Minradius) is chosen as whatever constant is suitable. Compute and store the longitudinal offset correction (Loff) in minutes of time.

Loff = (Meridian - LocLong) * 4

2) With Jan 1 being the first day, for each day of the year (Day) compute and store the Equation of Time (EoT(Day)) value in minutes of time, the Declination of the sun (Decl(Day)) value in degrees, and the half-day length (HDL(Day)) value in degrees.

3) Set up a normal Cartesian coordinate system and a modified polar coordinate system, which share a common origin, the center of the dial (that point towards which the hour lines converge). In our Cartesian system, the x-axis runs east-west, and x increases to the east. The y axis runs north-south, and y increases to the north. In our modified polar coordinate system, the polar axis (polar coordinate system axis, not to be confused with a pole style) lies along the y axis, and angles increase clockwise. We'll compute values thinking polar coordinates, but convert to Cartesian (x,y) before plotting our data.

4) Draw the sunrise "hour" line by connecting plotted points for each day of the year, where each point has polar coordinates (R, Theta).

R = distance from origin = Minradius + Day,

Theta = angle from polar, or, y axis = ATAN (SIN(PHI) * TAN (HDL(Day))).

Converting to Cartesian coordinates,

x = R * SIN (Theta), y = R * COS (Theta).

In a similar manner, the sunset line is computed and drawn.

5) The desired hour lines and fractionals are drawn in a similar manner, except that the hour angle (HA) is modified by including the EoT and Loff.

R = Minradius + Day,

HA = (hours from noon) * 15,

Theta = ATAN (SIN (PHI) * TAN (HA + (EoT(Day) + Loff) / 4).

6) The date arcs are centered at the origin and drawn with a radius R = Minradius + Day, where Day is the day number in the year for that date. Each date arc begins at the time of sunrise and ends at the time of sunset for that date.

7) The last step is often the hardest - placing on the dial plate text, numerals, and decorations, which are legible as well as pleasing.

Notes

It is usually sufficient to compute and plot data for every 3rd day. And remember to check for correct trig quadrants.

The process for drawing polar dials with unfolded analemmas and parallel date lines is similar to the above, but the polar coordinate system is not used--only a Cartesian system. The y axis lies along the substyle and increases north; the x axis increases to the east. The first of the date lines, which are all parallel to the x axis, crosses the y axis at (0,1).

The steps listed above are not the only way, nor best way, simply what worked for me.

REFERENCES

Gianni Ferrari, “Monofilar Sundials”, The Compendium 5-3, September 1998 p.5-7

John Singleton, “Horizontal Dial with Equation-of-Time Built In”, British Sundial Society Bulletin vol 12(i) p.51, February 2000

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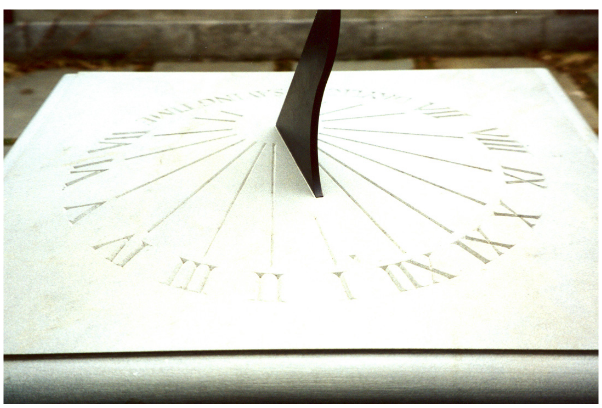
Sightings ... In The Yard

Steven Woodbury (Springfield VA)

Harvard University has an elegant new sundial, which tells only the summer hours. It is elegantly and simply carved in bluestone, and stands on a square sandstone pedestal. The dial was designed by William J. H. Andrewes, former curator of the Collection of Historical Scientific Instruments at Harvard. The dial face was cut by John Hegnauer, and the gnomon made by Richard Ketchen.



The dial plate is 22” across with Roman numerals from VII to VII (with additional lines for 5:00 a.m. to 9:00 p.m.). The dial incorporates a correction for longitude, but also includes a mark for local noon. Since the garden is open to the public only between April and October, the dial shows only daylight savings time.

The dial is located in a small garden behind the Lamont Library, backing onto Massachusetts Avenue; the garden is accessible from Harvard Yard. The garden was originally created in 1949 to honor Thomas Dudley (1576-1653) second governor of the Massachusetts Bay Colony. Dudley was also a member of the first Board of Overseers of Harvard College, and father of poet Anne Bradstreet. “During the revolutionary days of 1969” according the Harvard Magazine, the garden “was closed to the public on account of various naughtinesses occurring within.” The Garden was restored and reopened in 1999, with the new sundial as its centerpiece.

Send your Sightings to…

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