AN INCLINED SUNDIAL

1. This sundial indicates the time and date with good precision without any adjustment or mental correction. The time and date are read by noting where the shadow of the point of the gnomen falls on the appropriate diagram. There are two planar diagrams, one for winter/spring, the other for summer/fall. The sundial mount allows the face to be rotated about several axes to achieve proper orientation.

2. The sundial face is oriented parallel to a plane tangent to a spherical Earth at the point where the local meridian crosses the equator. Since the sundial is located in Florida, the plane of the face is inclined to the local horizontal at the angle of the local latitude. The x-axis of each diagram is horizontal. The (x,y) coordinates of points on the hour lines were calculated for the 1st, 8th, 15th, and 22nd of each month of the year for hours 8 AM - 4 PM. The points were then plotted on graph paper, connected using French curves, and then traced on tracing paper. The tracing was then scanned and laser printed by a commercial printer on a heavy, outdoor plastic sheet. That sheet was then attached by screws to the wooden mount.

3. There is a continuous and significant variation in the Sun's position (declination and equation of time) throughout each day. Also, because of leap year and other effects, the Sun's position on a specific date changes from year to year. In this design the variation throughout the day was not calculated, but could have been estimated fairly easily by applying a linear rate; instead, the Sun's position at local standard noon was used. The variation from year to year could not be compensated because this sundial cannot sense the year; so the Sun's median noon position over a leap cycle was used. The tabulation of this data was quite laborious.

4. The atmospheric refraction is significant at low Sun altitude. The refraction table in the Nautical Almanac was applied in the calculations.

5. The gnomen is rod parallel to the Earth's polar axis and located at a scale factor height above each dial diagram. Each gnomen has a conical point with a half-angle of 45 degrees. Because of the Sun's angular width, the umbra of the gnomen point is displaced along the axis of the gnomen toward the base of the cone. The displacement varies somewhat with declination and can be calculated; but in this design the value at zero declination was used (.25 deg x sqrt 2 = .35 deg).

6. The calculation of points on the hour lines was as follows:

L = location
NP = north pole
ASU = apparent Sun uncorrected for atmospheric refraction
ASC = apparent Sun corrected for atmospheric refraction
E = point where the local meridian crosses the equator

a. Step 1: Solve the spherical triangle L-NP-ASU. The length of arc L-ASU is the complement of the actual Sun elevation. Apply the correction for atmospheric refraction to get ASC.

b. Step 2: Solve the spherical triangle E-L-ASC. The angle L-E-ASC is the azimuth of ASC at E. The arcE-ASC is the complement of the elevation of ASC.

c. Step 3: Using the values found in Step 2 above, calculate the (x,y) coordinates of the shadow of the gnomen point. Apply the the umbra correction to the y coordinate.

7. The dial faces for this design were calculated using xcode (C++) on an Imac. I also have Microsoft Fortran code to do the same, but no longer have Fortran on my computer.