A Stained Glass Window Sundial

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I was excited to read Tom Shepard's recent article in the Compendium (3:3, September 1996) about how he designed and built a vertical declining sundial for his home in Florida. My wife and I were concurrently building a vertical declining dial for our house in Tennessee; however, we were using stained glass instead of the more conventional materials such as wood or stone. After joining the North American Sundial Society (NASS) a few years ago, I became interested in building a unique dial that not only would be distinctive in design, but also in construction. My wife is an expert artisan with stained glass so it was natural that we decided on this material for our dial. At the time, I had never seen nor heard of such a dial, but shortly afterward I bought Alice Morse Earle's book, *Sun-dials and Roses of Yesterday*. On page 53, she displays a picture of an old window dial located near Manchester, England and explains how such a dial may be viewed from both outside and inside the house. Rather than using the dial face for the window glass as in older designs, we were going to place the stained glass dial face on the inside of an existing window with the gnomon still positioned on the outside.

The window we chose was a 30 inch diameter circular pane of glass that was about 15 feet above the entrance hall to our house. Tom Shepard's excellent article covered the details of how to design a generic vertical declining dial so I will limit my comments to those areas of design and construction that were unique to our stained glass dial. Like Tom, I first measured the declination of the window using the techniques listed by Waugh in his book, Sundials: Their Design and Construction. After a series of observations, I determined that my wall/window declined between 62.9 to 64.0 degrees East of South. Noting that all measurements were within a degree, I averaged the readings to obtain a final declination of South 63.5 degrees East. With my limited construction skills, I knew that a half-degree design error, if any, would make little difference in the finished product.

Once I knew the window declination, I determined the house latitude and longitude from a U.S. Geological Survey map. I then computed the dial's vital statistics such as hour angles and style height using a simple calculator. Fortunately, I also obtained Zonwvlak, the outstanding computer program, from NASS to check my hand calculations. The results agreed completely. Zonwvlak was especially helpful in calculating a date/declination line that we added to the final design. Hour lines were calculated with a correction for longitude. Since our house is located at 83 degrees, 59 minutes West longitude, a correction of 35 minutes, 55 seconds was built into the dial to account for the difference from the Eastern Time Zone standard longitude of 75 degrees West. No correction was made for nor have I attached a table displaying the equation of time. We also did not label the hour lines although it would have been easy to do so. We felt that labels would clutter the dial face, would be difficult to see from the outside unless they were unusually large, and would appear backwards from the inside. Besides, not having hour lines adds a certain sense of mystery to the dial. Also, the dial was designed to compensate for the width of the style; in our case about half an inch. Accordingly, the dial face was "split" in half along the bottom of the style and a 1/4 inch space added to each side. Finally, a vertical line was incorporated to not only show local apparent noon, but to assist in dial alignment.

During the early stages of the design process, I noted that the window was shaded during the afternoon hours by the house's horizontal eave and the wooden frame that surrounded the circular window. Although I had calculated hour lines up to 6:00 PM, it made little sense to include those hour lines that were shadowed by the house. Through a series of observations in the summer months, it became apparent that any hour lines after about 1:00 PM standard time were shaded and therefore were useless. My only question was whether these same hour lines would be shaded in winter months when the sun's declination was less. After a good bit of research, I gave up on finding information on the shading effects of differently shaped overhangs/surrounds. Somewhat frustrated, I finally wrote a computer program which precisely calculates the shadow cast by any irregular surface at any hour of the day for any sun declination. For our dial, the program confimed that the 2:00 PM and later hour lines were not needed, as the sun's shadow would never reach them before the dial was shaded.

Using the Zonwvlak program, I generated a computer image of the initial dial design. I then transferred the image to a computer graphics program where I could play with the final design by offsetting the dial center from the window center, adjust the relation of the edge of the dial to the date/declination line, and change colors of the different hour sections. My wife and I agreed the most aesthetically pleasing design had the dial center offset up and to the right of the window center. In the final design, the dial center was completely off the dial face and window. The offset spread out the usable hour lines and equalized glass between the edge of the dial and the 6:00 AM and 1:00 PM hour lines. I also determined that the date/declination line never reached the 1:00 PM hour line so the edge of the dial was simply positioned where the date/declination line crossed the 12:00 noon hour line.

The date/declination line depicts the date on which we bought this house. We toyed with using our anniversary date, but felt that because this dial was unique to the house and would be inaccurate if moved elsewhere, the closing date was more appropriate. This leaves us our anniversary date to be designed into a future dial for the garden.

As those of you familiar with stained glass are already aware, there appears to be an almost infinite variety of colors and textures from which to choose. However, window dial glass must satisfy two conflicting criteria. To allow the dial to be read from both inside and outside the house, we needed glass that was opaque enough to hold a shadow on the outside, but transparent enough to see the shadow from the inside. After several visits to local supply stores where we viewed countless specimens of glass, we decided upon a type of glass commonly known as "whispy". The colored areas of the glass are sufficiently transparent to allow some light and shadow to pass through while the white wavy portions capture the shadows well enough to be easily visible. For simplicity, we chose two contrasting colors, green and yellow, that matched our house brick and trim.

Actual construction of the dial face was straightforward using normal stained glass techniques. My wife was capable of making a much more complicated project, as evidenced by many of her other stained glass pieces, but we both felt that a simple pattern would produce the most legible sundial. Instead of soldering the glass pieces together, lead came and putty were used. Lead came was also bent around the perimeter of the dial for added strength. The finished product had a slight flex along the six/twelve axis, but since the dial face would rest on mounts rather than hang from above, flex was not a major concern. As a final touch, a small spot of solder was placed at the location of the foot of the perpendicular style for alignment of the gnomon's nodus.

The gnomon was constructed of wood topped with aluminum U channel for the style. The wood was covered with several coats of exterior grade latex to match the house trim while the style and fixtures were spray painted with enamel. Brass fittings were used to connect it together. Finally, a brass T bar was attached to the top of the style to form the nodus that casts the date/declination line shadow. I look forward to seeing how well the gnomon weathers. Should the wood not endure, I will probably make another gnomon completely of metal for better longevity.

One major complication arose during gnomon construction. In a normal window dial whose face acts as the window glass, the gnomon is placed directly on the dial face. Adjustment of the gnomon is then fairly easy - the top edge of the style must align with the origin of the dial where the hour lines converge. However, our dial face was to be placed inside the existing window with the gnomon attached to the outside. I had no way of measuring the precise thickness of the window glass and the dial's origin was an invisible point located several inches off the window in our offset design. Yet I still needed to align the style with the origin by placing the style at the correct height above the dial face. To compensate for any height errors, I designed the

gnomon with vertical slots that allow it to be raised or lowered over a range of one inch.

By adjusting the ends of the gnomon up or down, I can place it at exactly the right height in relation to the dial face and offset origin. The brass T bar nodus was also designed so that it can be moved up and down the style to precisely locate it over the style foot.

The stained glass dial face was rested on wooden mounts and secured to the inside of the wooden window frame with metal clips obtained from our local glass dealer. The vertical local apparent noon hour line was aligned using a carpenter's level. While installation sounds rather easy, it was a bit of a handful while standing alone on a sixteen foot step ladder.

On the outside, the gnomon was carefully checked for proper alignment with the hour lines and secured with brass screws and straps to the wooden frame. The T bar nodus for the date/declination line was moved directly over the solder mark we had previously placed on the dial face at the position of the perpendicular style foot.

I monitored the dial for the next couple of days to check its accuracy. After comparing dial time with clock time, it was apparent that the dial was reading too fast by about ten minutes. This was caused by the gnomon being positioned too high above the surface of the dial face. After trimming off the bottom of the gnomon and extending the vertical adjustment slots, the style was finally lowered to the proper height by simply aligning its shadow with the correct hour line as adjusted for the equation of time.

Now that the dial is in place, my wife and I enjoy watching the sunlight play through the dial face and fall upon the hallway walls. The dial's design, complemented by the glass colors, makes a beautiful pattern on the interior while simultaneously adding a unique decoration to the exterior of our house.

We had a great time designing and building it together and look forward to admiring it for many years to come. And to think that it even tells the time too!

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