

## Back to Basics – Design By Drawing

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Can you believe it? I am still writing this! My hope has been to add a little something that beginners like me can readily understand. However, another requirement has been not to repeat things either from this column or other articles. Now that is hard. My tactic has been to break up our interest into four areas, one for each issue of the year. These are 1) Looking, 2) Drawing or Designing, 3) Construction and then 4) anything else. This has worked for the last two years but I am running out of new approaches.

### Help!

Maybe some new readers could add questions or ideas. I am grateful for the ideas sent by the more experienced, but I would really like to hear from beginners. (See my address at the end.)

### Design by Drawing

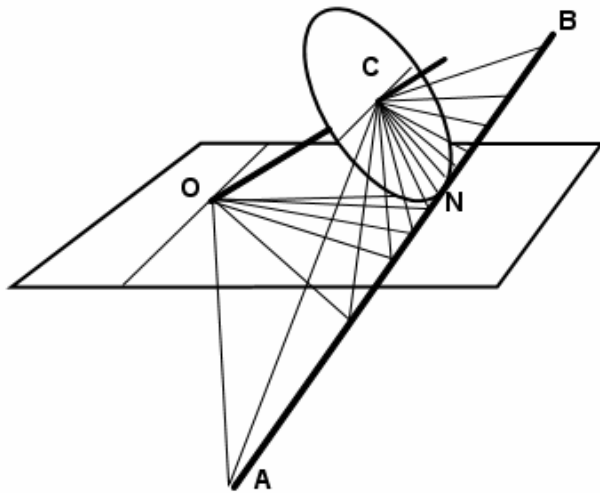


Figure 1. Equatorial Sundial Used as a Guide

Graphic constructions look confusing. Both the books by the Mayalls and by Waugh do little to explain why certain lines are drawn. The book by René R. J. Rohr, *Sundials, History, Theory, and Practice*, (Dover Publications) does explain and derives the often-used equations from them. Here is a simple description similar to what is found there.

When you follow the instructions of Waugh or the Mayalls you may not know what is being done and as a result it is easy to make mistakes and impossible to make your own variations. I never gave these much thought until Larry Smith sent me a drawing in which the first step had a little artistic addition that revealed that I was looking at a gnomon from the side. That sent me to Rohr's book to confirm what the procedure was all about.

Basically all these graphic procedures are drawing views of an equatorial dial. Remember that one of the easiest dials to construct is a disk, with hour lines every 15 degrees, mounted on a polar gnomon. Figure 1 is a perspective view of such a dial.

In this figure we see the equatorial dial set up on a horizontal rectangular plate on which we wish to draw a sundial. As explained in the first Back to Basics column, Compendium 8 – 2, the hour lines can be found using the equatorial dial. As shown in figure 1, each hour line on the equatorial is extended from the center C down to the horizontal plane. Of course, they all intersect this plane along the line labeled A B. The point N is for the noon line. Now the hour lines for the horizontal dial are drawn from the origin of the polar style, O, to the intersection points on AB. (In the figure, only half of the lines are drawn for simplicity.)

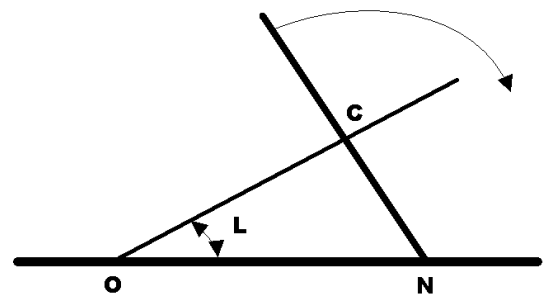


Figure 2. Side View of Gnomon

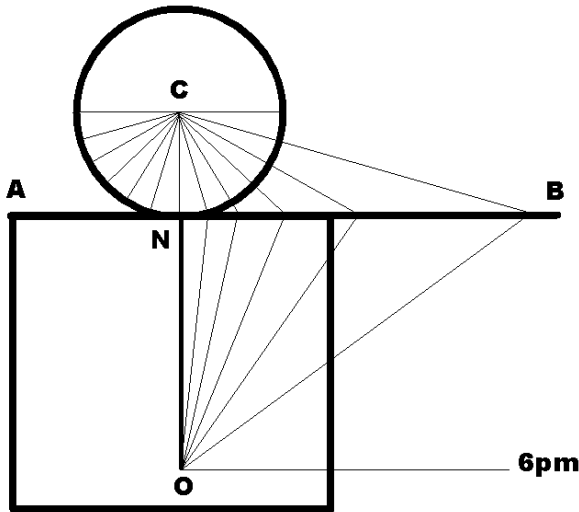


Figure 3. Horizontal Sundial Drawing

how far from O to place the line AB. This is found by making a side view of the gnomon as shown in figure 2.

The line OC is the polar style making the angle L with the horizontal plane ON, equal to the latitude for the dial. The line CN is the edge of the equatorial whose center is C. The important thing to get from this view is the distance ON which depends on the angle L and the size of the Equatorial's radius, CN. Sometimes you see this figure drawn on the noon line of the dial. (I guess that is to save paper?) I prefer to make a separate drawing and just copy the distances ON and CN.

In order to make a flat drawing we imagine folding down the equatorial in the direction of the curved arrow in figure 2. This is like folding flat a model equatorial as shown in figure 1 along the line AB. The drawing that is made looks like figure 3.

Now we see the horizontal dial from above. The rectangle is the plate of the dial. Above it is a drawing of the equatorial dial laid down on the horizontal plane. We see its hour lines extended to the intersection of the line AB. The hour lines for the horizontal are drawn from O to these intersections. (Only half have been drawn as before.) The 6 am and 6 pm line for a horizontal dial we know must be perpendicular to the noon line ON. If you want the hour lines before 6 am or after 6 pm, extend the hour lines after 6 am or before 6 pm.

A particular confusing detail is the method some texts use to get the hour lines that extend far out to the sides. In my drawing I take the simplest approach: extend the line AB as far as needed.

This method of drawing the equatorial dial above its intersection can be used for all kinds of dials. If a vertical dial is desired, just imagine folding the equatorial in the other direction as shown in figure 4.

In this figure we see the equatorial dial set up on a horizontal rectangular plate on which we wish to draw a sundial. As explained in the first Back to Basics column, Compendium 8 – 2, the hour lines can be found using the equatorial dial. As shown in figure 1, each hour line on the equatorial is extended from the center C down to the horizontal plane. Of course, they all intersect this plane along the line labeled A B. The point N is for the noon line. Now the hour lines for the horizontal dial are drawn from the origin of the polar style, O, to the intersection points on AB. (In the figure, only half of the lines are drawn for simplicity.)

The graphic solutions that are shown in many texts do the same thing but all on a single, flat sheet of paper. In order to do this we first find

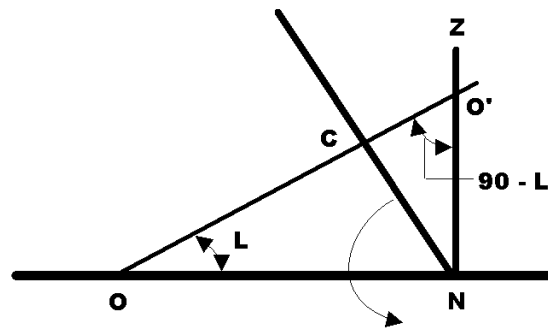


Figure 4. Vertical Gnomon

Here the style penetrates the vertical surface, ZN, at O'. Now the important distances are CN as before and NO'. With these distances we can make our drawing of a vertical in figure 5. Imagine folding the equatorial in the direction of the curved arrow of figure 4.

The vertical dial's drawing looks very similar to the horizontal one. (I could have drawn it in the same orientation but that would have made the dial upside down.) The important difference is the distance NO'.

The vertical dial poses some special circumstances when it is not facing directly south (*declining*) or not exactly vertical (*inclining*). In theory, the drawing

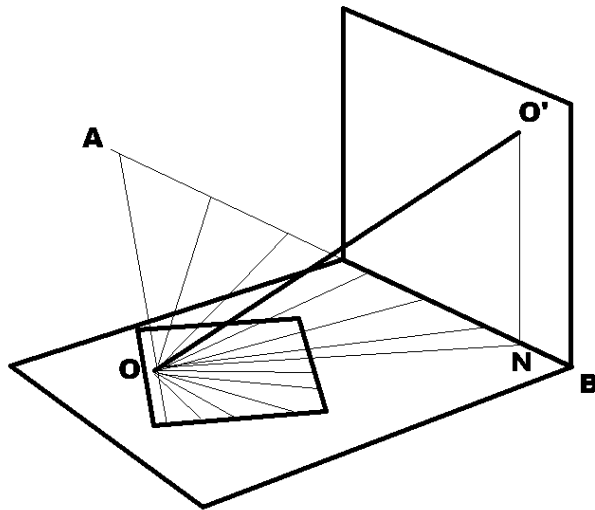


Figure 6. Vertical Declining Wall and a Horizontal noon line at N. The difference is that instead of perpendicular to the line of intersection, the noon line of the horizontal makes an angle less than  $90^\circ$  due to the declination,  $d$ . When we fold down the horizontal plane into the vertical we get something like figure 7.

Note how the origin of the vertical hour lines is on a perpendicular to the intersection at N. This is because we know this will be true if the vertical does not incline. If it does, a lot more work must be done and I leave it at this point.

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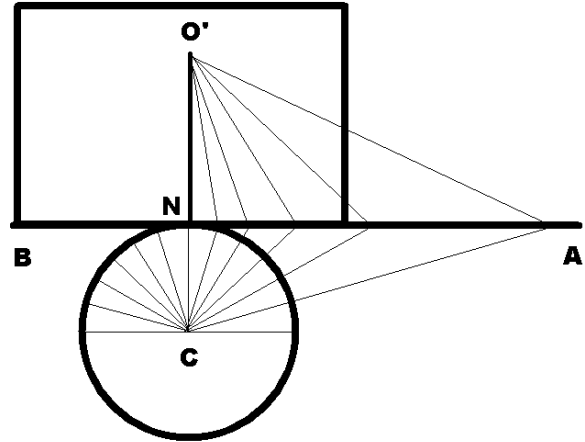


Figure 5. Vertical Sundial Drawing

procedure can be derived in the same way: picture an equatorial dial mounted on a proper polar dial mounted above the surface. The trick is now to find the distances and orientation of the intersection of the equatorial's plane and the dial's plane. That can be complicated. In Rohr's book, he shows that a simplification can be done with the use of a horizontal dial. Look at figure 6.

Here we see a horizontal plane intersecting a vertical plane that does not face due south. On the horizontal plane is placed a horizontal dial. The polar style of that dial will become the style of the vertical dial. Notice that we can merely extend the hour lines of the horizontal dial to the line of intersection. (As before, only half of them are shown.) Again we need the distances to the origins ON and NO' from the intersection of the

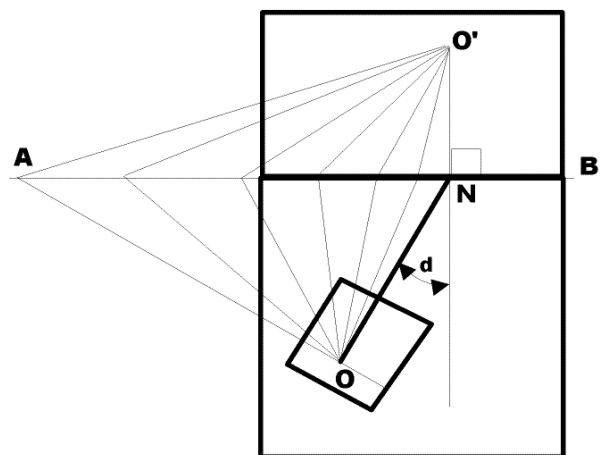


Figure 7. Vertical Decliner Drawing