

Your Mileage May Vary (Gary Guenther)

Tips

Hints

Ideas

Tricks

This month, we have an article submitted by a guest author: Dennis J. Gooding, a.k.a. "Dennis in Southern Oregon" on the WoodCentral online forum that we both frequent. Dennis did such a great job of presenting this practical and effective method for turning spheres there that I asked him if he would do it for us, and he kindly assented. Welcome, Dennis, to MCW.

Here's a little bit about Dennis, in his own words:

"I am a retired Professional Electrical Engineer who, upon retirement, left the snow and population crush of the Boston, MA area for the temperate climates and wide-open spaces of Southern Oregon. Getting a bit bored with retirement, I dragged out a tiny crude lathe that I had used just once thirty years previously to turn pedestals for a coffee table, and started puttering around with it. I surprised myself by turning, what seemed to me then, some decent pieces.

This was twenty years ago. Since then, I have upgraded a couple of times, and woodturning has become my main hobby. I like to explore new and different kinds of pieces, particularly challenging ones. The engineer in me is always looking for a better way. I turn for fun and relaxation rather than profit. Almost all of my work, aside from my personal collection, has been gifted to friends and family or donated to charitable causes. Some of my work can be seen in the WoodCentral gallery and the AAW gallery. Any comments or questions can be directed to me at djgood@ieee.org.

Simple Aid for Turning Spheres without a Jig by Dennis J. Gooding

There seems to be considerable interest lately in a certain structured procedure for turning spheres by hand. Apparently, Sören Berger and Al Hockenberry independently discovered the basic concept and both have popularized it for several years. The procedure involves first turning a cylinder with a length and diameter equal to the diameter of the desired sphere. The outline of this cylinder will appear as a square. The corners of this square then are sliced off in a straight line to produce an 8-sided outline that approximates a sphere. Optionally, one can continue the process by turning off the new corners to form a 16-sided approximation, and this can be continued further into finer approximations if desired. The final result, from whichever level, can be smoothed out by eye to produce a pretty good sphere.

The following three images illustrate the sequence for the 16-sided approximation.



Stage 0 (square)

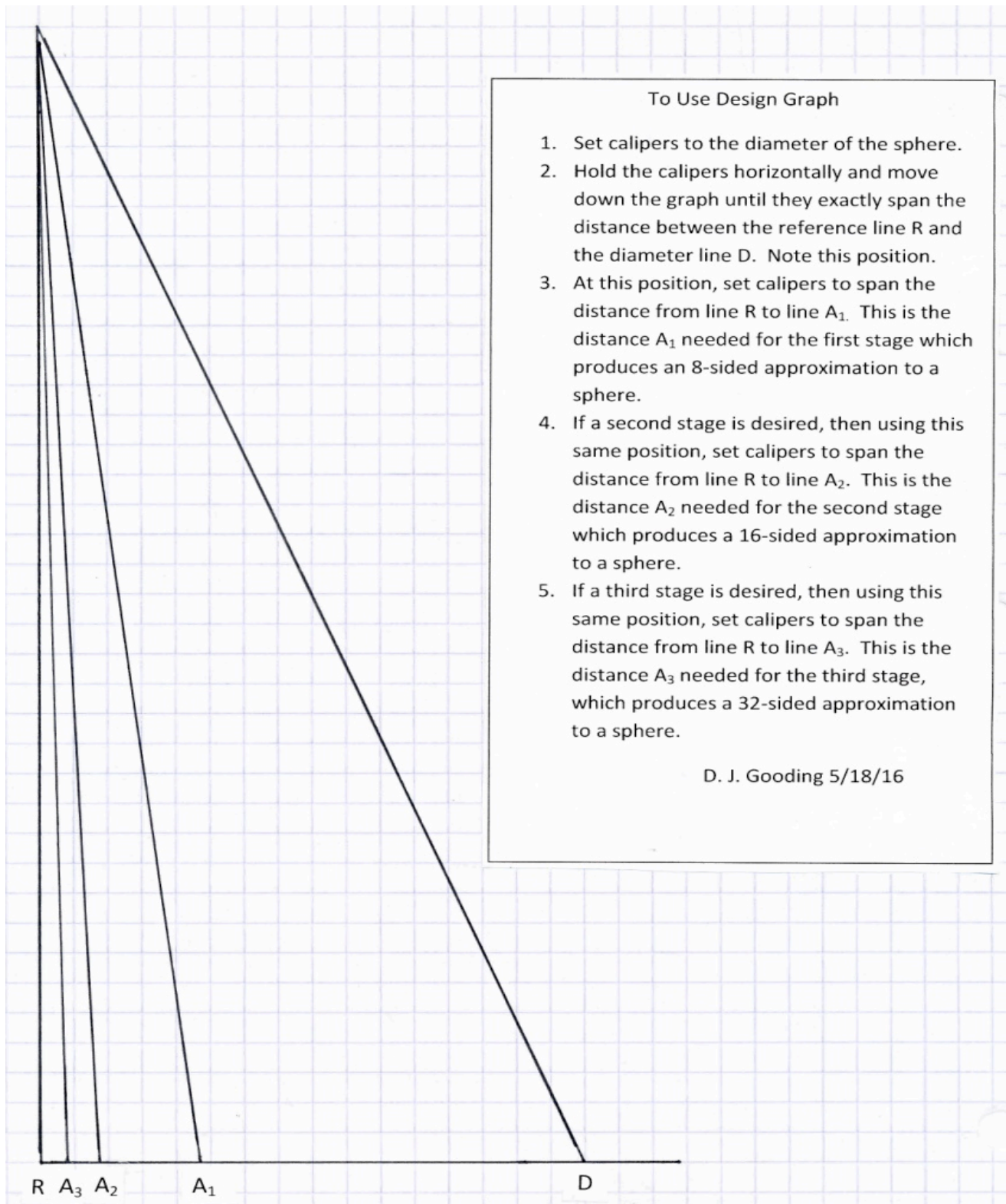
Stage 1 (8-sided)

Stage 2 (16-sided)

I personally have used this method many times to turn spherical ornaments, and spheres that become the bowls of one-piece ladles and spoons, and find it fast and convenient. (I generally stop at the 8-sided stage.) Although I have never used a sphere-turning jig, I expect that this method is far faster (and certainly a lot cheaper) than using a jig, if you do not require high accuracy. Furthermore, it strikes me that this method would be a time-efficient way of roughing out a sphere before using the jig.

The catch (no, not that kind) is that in order to make these cuts, you first need to determine where to mark the boundaries of the cuts. At each stage, you need to mark the piece at a particular distance each side of the existing corners. In the first stage, which produces an 8-sided approximation, the required distance is 0.293 times the diameter of the sphere. In the second stage, which produces a 16-sided approximation, the required distance is 0.108 times the diameter of the sphere. Unfortunately, unless you have a calculator in the shop and a decimal ruler or calipers, this calculation and measuring can be challenging. One option is to purchase the \$70.00 multi-calipers measuring tool from Sören Berger that, when set to the diameter of the sphere, provides direct indications of the offsets needed for Stage 1 and Stage 2. For those who cannot justify the cost of this tool, I would like to offer a simple, fast, no-cost, no-math alternative that anyone can use. This method makes use of a simple design graph, as shown below.

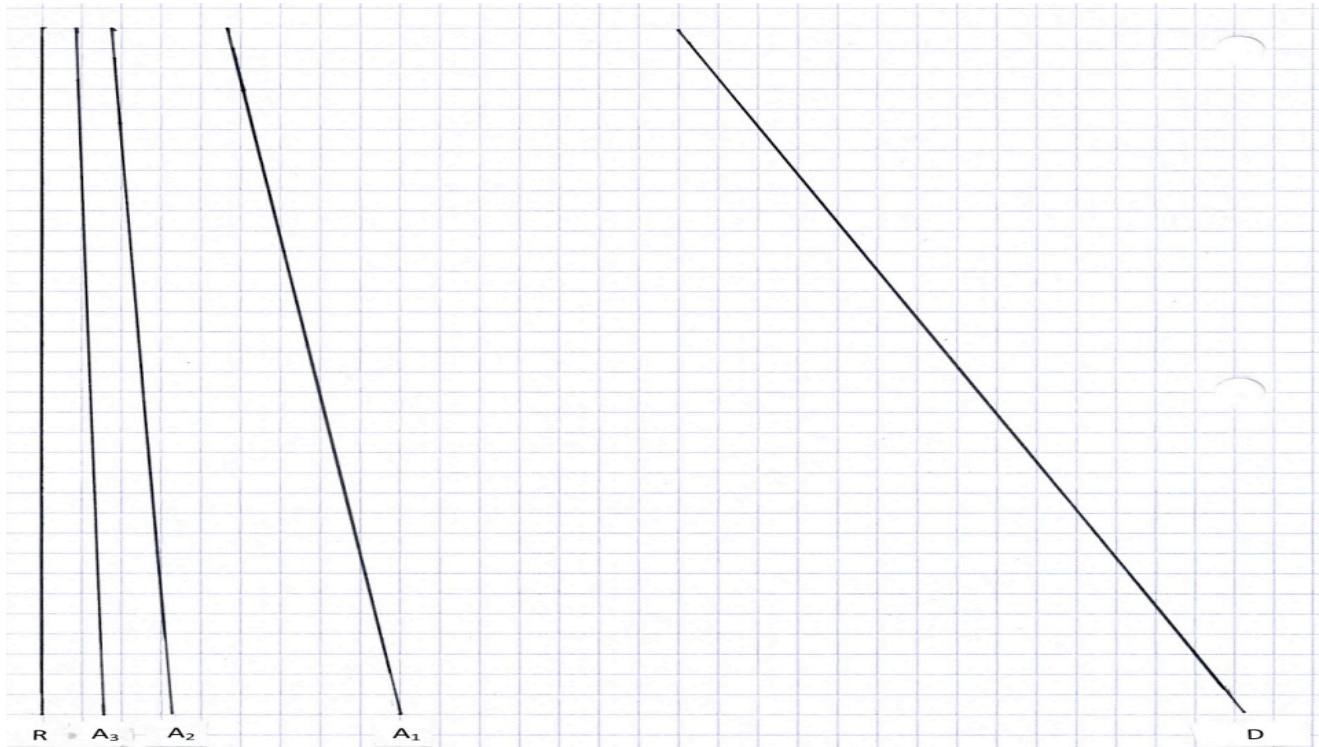
The first graph (on the next page), when printed, will let you measure the desired quantities directly, using calipers or a strip of paper, for spheres up to just over 3-1/2 inches in diameter; an extension plot follows that will go up to 6 inches. Because the measurements are proportional, relative to the selected diameter, these charts are dimension free, and the figure can be printed at any size as long as it covers the largest sphere diameter desired.



To Use Design Graph

1. Set calipers to the diameter of the sphere.
2. Hold the calipers horizontally and move down the graph until they exactly span the distance between the reference line R and the diameter line D. Note this position.
3. At this position, set calipers to span the distance from line R to line A₁. This is the distance A₁ needed for the first stage which produces an 8-sided approximation to a sphere.
4. If a second stage is desired, then using this same position, set calipers to span the distance from line R to line A₂. This is the distance A₂ needed for the second stage which produces a 16-sided approximation to a sphere.
5. If a third stage is desired, then using this same position, set calipers to span the distance from line R to line A₃. This is the distance A₃ needed for the third stage, which produces a 32-sided approximation to a sphere.

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To use the graphs, first set your calipers to the diameter of the desired sphere. Then, hold the calipers horizontally and slide them down the graph until they exactly span the distance between the reference line R and the diameter line D. Mark this vertical position on the graph with a horizontal line parallel to the rulings. For the offset A_1 , that is required for the first stage, use your calipers (or a strip of paper) to measure the distance from the line R to the line A_1 along the horizontal line and use it to mark cut lines on the work piece at that distance each side of each of the corners. To obtain the offset A_2 for the second stage, do exactly the same, except copy the distance between line R and line A_2 . Similarly, for a third stage, copy the distance from line R and line A_3 . When performing the cuts across a corner at any stage, be sure to leave a vestige of the original guide lines showing. These mark the new corners that will be removed in the next stage. Also, to avoid confusion, it will be helpful to change marking colors between stages.

To draw a graph for yourself that will accommodate spheres of up to 4 inches diameter, obtain a sheet of quadrille paper (I used $\frac{1}{4}$ " ruled paper, but any will work) and mark a point near the top left of the sheet, as shown in the first figure, and draw a vertical line down to one of the rulings near the bottom of the sheet. This is the reference line R. Then draw a horizontal base line as shown. Measuring from the R line along the base line, mark points at 0.20" ($\frac{7}{32}$ "), 0.43 ($\frac{7}{16}$ "), 1.17" ($1\frac{3}{16}$ "), and 4.00 inches. Alternatively, if you prefer to span di-

imeters up to 6 inches on a single graph, at possibly some loss of accuracy at small diameters, make the marks at 0.30" (5/16"), 0.65" (5/8"), 1.76" (1-3/4"), and 6.00". The fractional measurements shown are close approximations to the actual decimal values for those who do not have decimal rulers. If you need to turn larger spheres you can easily extend the range of the graph. Carefully align a second sheet of quadrille paper with the original piece, offsetting it to the right if necessary, and extend the lines R, A₁, A₂, A₃ and D onto the new sheet.

The length of the line R is not critical; however the longer it is for a given maximum value of D, the more accurate the procedure will be (the measurements of A₁, A₂, and A₃ will be less sensitive to small errors in vertical positioning of the calipers on the graph). I wanted to be able to handle up to 4-inch spheres with one sheet of paper, and this led to the first graph shown. (Note that the publication process has led to slight shrinkage of the figures.) As noted above, in principle, this procedure can be extended to additional stages (more sides), but unless the sphere is very large, errors in measurement and marking will tend to blur the benefits. For those interested in trying, further values of A are easily added to the graph. The A line for each new stage moves halfway in toward the R line from the preceding A line. In other words, the line for A₄ will lie almost exactly halfway between the line A₃ and the reference line R, and so on for further stages.

Mathematical Basis for the Procedure

Consider the profile of the turning as viewed from the front. The procedure begins with a square profile of height and length equal to the diameter of the eventual sphere. Stage 1 of the procedure slices off each corner of the square and replaces it with two corners a distance A₁ on either side of the old corner and produces an 8-sided figure. Examination reveals that A₁ is equal to half the difference between the length of a side of the old square and the length of a side of the new 8-sided figure. Furthermore, this relationship is true for all subsequent stages as well. That is, the value of A needed in a given stage is equal to half the difference between the length of a side before performing that stage and the length of a side produced by that stage. Applying a bit of elementary trigonometry, we find:

$$A_1 = \frac{D}{2} \left(\tan \frac{\pi}{4} - \tan \frac{\pi}{8} \right) = 0.2929 D$$

$$A_2 = \frac{D}{2} \left(\tan \frac{\pi}{8} - \tan \frac{\pi}{16} \right) = 0.10765 D$$

$$A_3 = \frac{D}{2} \left(\tan \frac{\pi}{16} - \tan \frac{\pi}{32} \right) = 0.05021 D \quad \text{and, in general, } A_n = \frac{D}{2} \left[\tan \frac{\pi}{2^{n+1}} - \tan \frac{\pi}{2^{n+2}} \right]$$

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Thank you, Dennis, for a very useful and educational article that will make it much easier for us to turn spheres without special jigs.

Always use common sense. Things that work in one situation may not work in another. Follow all Safety Rules. If it feels wrong, it probably is; stop and rethink. Your Mileage May Vary