SEGMENTED TURNING

Segmenting 101

The greatest difference between segmented turning and traditional turning is the turner must decide what final form the turning will take even before the first cut is made. Although there are countless possibilities as to the form and design, once the segmented turner sets the course, there is very little leeway for deviation from the original design. So planning is the crucial part of the entire process. Typically, segmented turnings are composed of stacked rings of varying sizes.

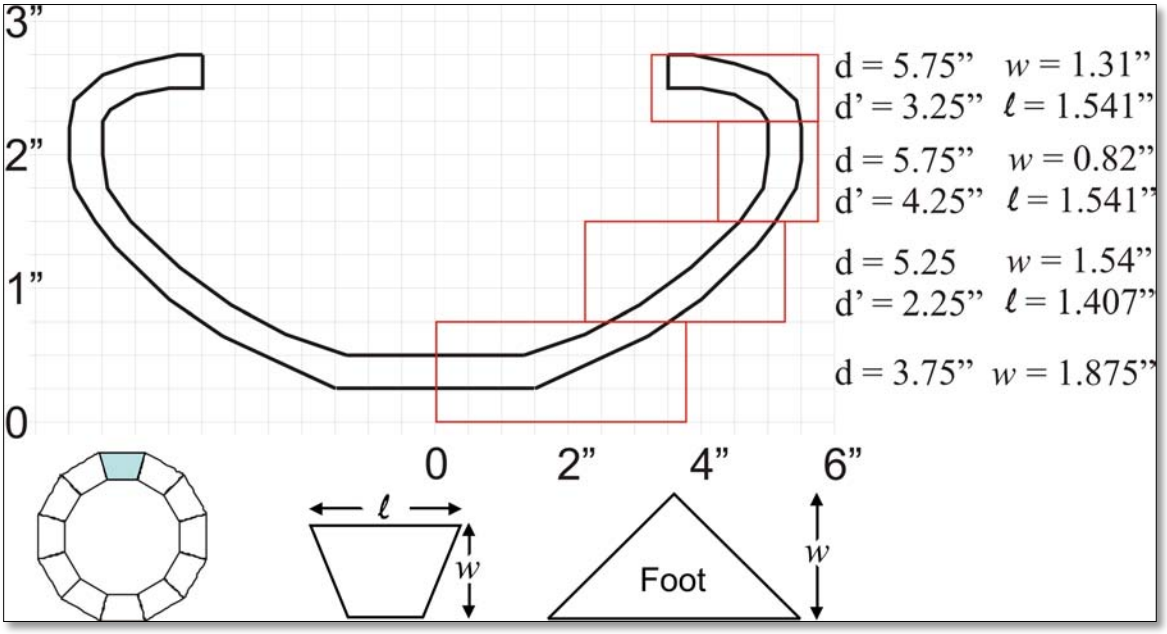

Figure 1. Design of a simple segmented bowl.

Figure 1 is a sketch of a simple bowl that is built from four segmented layers. It was designed by hand drawing on a traditional graphing paper. The dimensions of the necessary segments are then calculated accordingly.

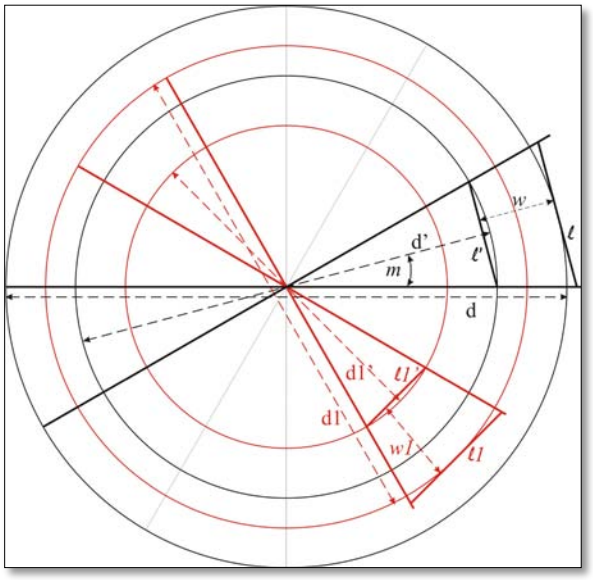

Figure 2. Calculation of segments on two overlapping rings of different diameters. The OD (d, d1) and ID (d', d1') of each ring are determined from the sketch. Note that the width of the segments is NOT the difference between the OD and ID.

m = 360°/2n
w =1/2(d - d' x cos m)
l = d x tan m
l' = d' x sin m
Board length for a ring = (l + l') x (n/2) + (0.125"/cos m) x n

n = Number of sides, m = miter angle, d = diameter of ring, d' = internal diameter of ring
w = width of segments, l = length of segments, l' = short length of segment (only for the calculation of the total board length), 0.125" = saw kerf

Non-italicized are assigned and *italicized* are calculated

Example For a ring with 12 segments, 6" OD, 4" ID

m = 360°/(2 x 12) = 15°
w = 1/2(6" - 4" x cos 15) = 1.068"
l = 6" x tan 15 = 1.608"
l' = 4" x sin 15 = 1.035"
Board length = (1.608" + 1.035") x (12/2) + (0.125"/cos 15) x 12 = 17.307"

Table 1

Layer	n = # of seg	*m* = miter angle	d = OD	d' = ID	*w = width of seg*	l = *length of seg*	l' = *short length*	Total board length	T = thickness
1 (Foot)	4	45	3.75		1.88	3.750	0.000	8.21	0.75
2	12	15	5.25	2.25	1.54	1.407	0.582	13.49	0.75
3	12	15	5.75	4.25	0.82	1.541	1.100	17.40	0.75
4	12	15	5.75	3.25	1.31	1.541	0.841	15.84	0.50

The formulae for calculation are all in the caption for Figure 2 which shows two overlapping rings of different diameters. Table 1 is a spreadsheet that is an actual printout from Excel which makes the process less painful. There are computer programs on the market that make life much easier, such as Woodturners Studio (woodturnerscatalog.com), Woodturner Pro (woodturnerpro.com), for example.

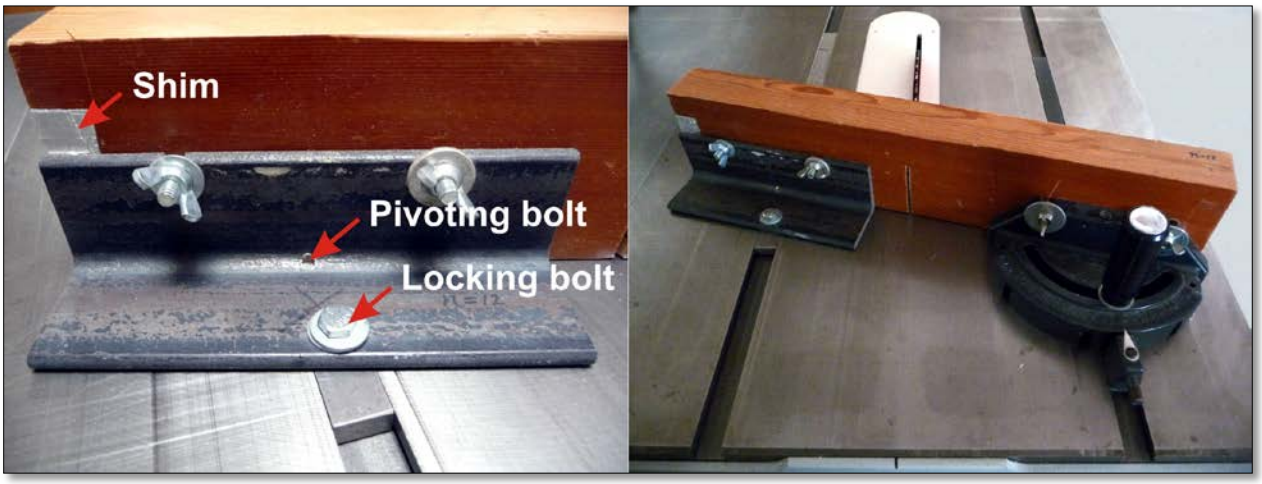

Figure 3. Miter gauges for cutting segments on a table saw.

Arguably, the most critical aspect of building a segmented turning blank is cutting the miter angle on segments accurately. I use homemade miter gauges that are dedicated to a certain angle for this purpose (Figure 3). The miter gauges are constructed of 2" x 2" x 1/4" angle iron and 3/8" x 3/4" steel bar for the guide bar. A preliminary angle is set by reference to a store-bought miter gauge and both the pivoting and the locking bolts are tightened. The final adjustment is made by making trial cuts and shimming the sacrificial fence until a perfect angle is achieved. A second adjustable miter gauge is also attached to the fence to eliminate any side play.

Figure 4. Making the foot (first layer). A: Gluing two quadrants together; B: Gluing two halves together after the facing surfaces are trued up; C: One side sanded flat on a disc sander; D: Tailstock used for centering/holding onto the waste block after glue is applied; E: Truing up the first layer. Note the center has been dished out for easy truing.

Procedure

The foot (bottom layer) is constructed with four equal segments cut diagonally to the wood grain. They are glued in two pairs. The facing sides of the two halves are trimmed on a table saw and the two halves are glued together such that the apexes of all four segments come to the center (Figure 4). One face of the block is flattened on a disk sander and glued to a waste block already trued up on the lathe. A center mounted on the tailstock is used to center the piece on the waste block, as well as to provide pressure while the glue sets. The block is turned round and the center of the block is dished out to nearly final depth before the edges are trued up to a perfectly flat surface.

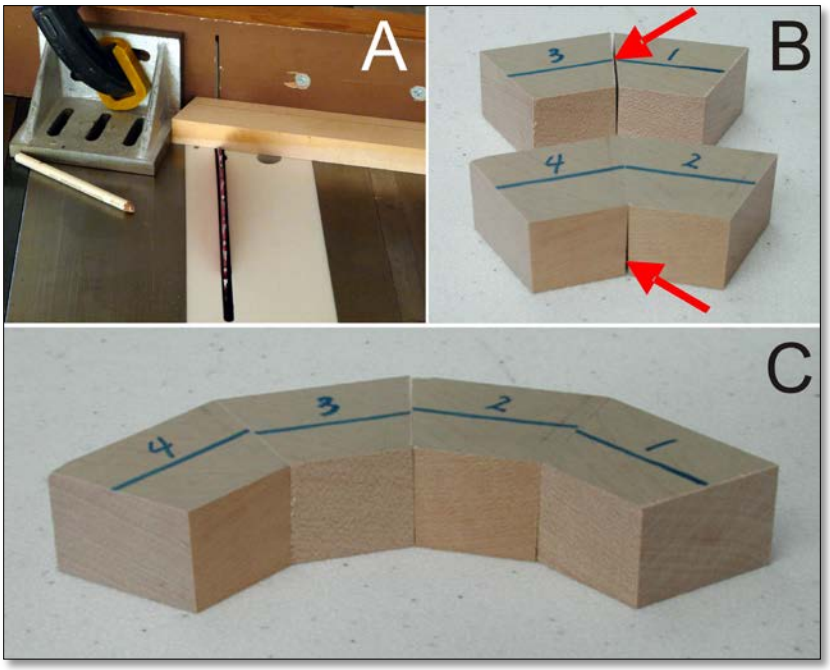

Figure 5. Cutting segments for subsequent layers. A: A stop is clamped to the sacrificial fence for repeatable length; B: Gaps resulted from a combination of imperfect adjustment of the saw blade and not putting segments together in the correct sequence; C: The minor imperfection is canceled out when segments are assembled in the correct sequence.

The other layers are built from segments cut using the miter gauge assembly described above using a stop block. Flip the strip of wood after each cut to produce trapezoids of identical size. Make sure the stop block is on the "open" side of the saw blade so that the cut off segments would not be caught between the stop and the blade (Figure 5A). Also note an old-fashioned pencil eraser is used to hold the segment down as you back the board out of the blade. It is important to mark one side of the wood strip with a pencil along the length of the piece before cutting. Flip over every other segment IN THE SEQUENCE they come off the saw so that the pencil-marked side faces up. This way, if the saw blade is not perfectly perpendicular to the table, the inaccuracy will be canceled out between segments (Figure 5).

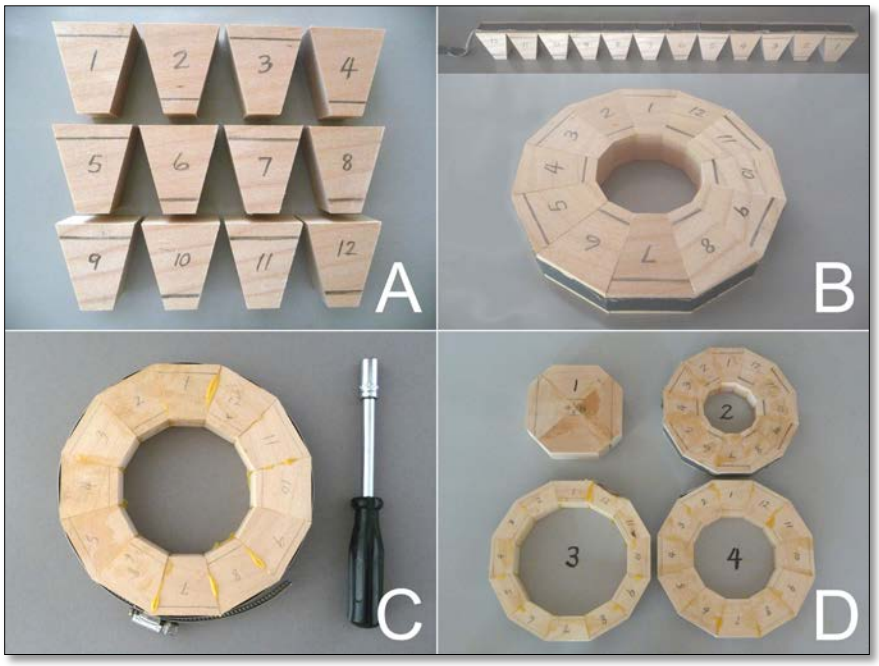

Figure 6. Gluing segments into rings. A: Twelve segments ready for assembly; B: Segments are wrapped around with a strip of duct tape to check for fit; C: A clamp is used to hold the ring together after glue is applied; D: All layers are glued together.

To check for a perfect fit, wrap the segments tightly together with a strip of duct tape to form a ring. If you do not see light between segments when holding the ring up against light, unwrap and apply wood glue between segments with the tape attached. After rewrapping the tape, snug up the ring with a hose clamp as shown in Figure 6. The duct tape ensures that all outside corners of segments are properly aligned and keeps them aligned while the glue is applied.

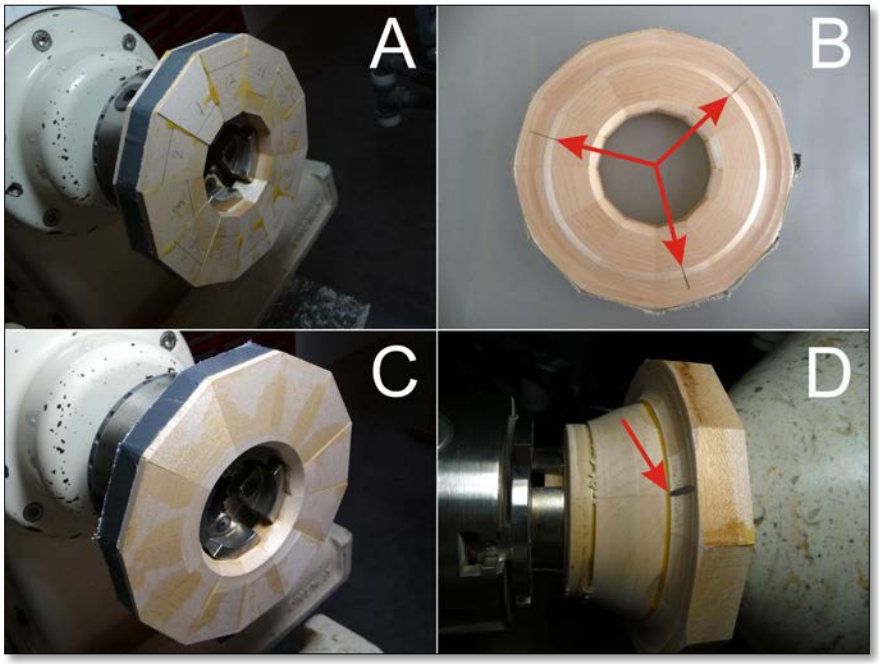

Figure 7. Truing up one side of the ring. A: Ring mounted for truing up one side (with chuck in expansion mode); B: One side of ring trued up and middle of segments marked; C: Center of second side rounded for perfect alignment; D: Second layer glued onto foot, pencil mark/seam lined up.

After the glue sets, true up one side of the ring and mark the middle of a couple of segments (Figure 7B) for easy alignment with the previous layer. (I true up the ring on the lathe. Notice in Figure 7B the outside of the ring has been turned away so you only need to true up the area that will be glued to the previous layer.) Use a cone that can be mounted on the tailstock for concentric alignment of rings as well as to provide pressure as shown in Figure 7D.

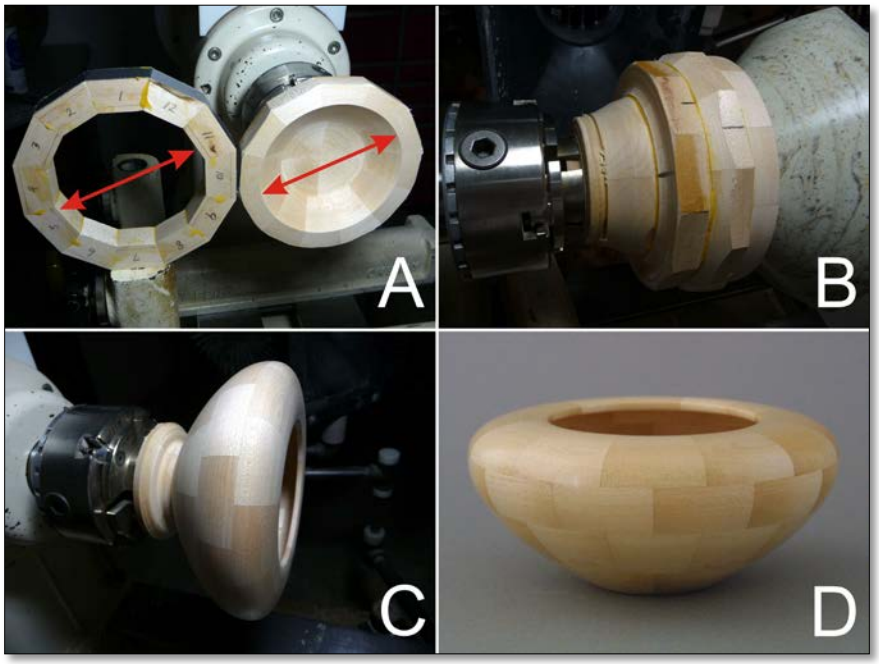

Figure 8. Assembling all rings and finish turning. A: Cut away the inside of the smaller ring - easier to true up; B: Glue all rings together concentrically using the centering cone; C: Finish-turn the outside and inside; D: Completed bowl.

True up the face and one side of the next ring and glue the new layer to the previous layer, again using the cone to center and provide pressure. Repeat the process until all the layers are glued together (Figure 8). Finish-turn the bowl after the glue is set. Sand to 320 grit on the lathe and apply your favorite finish.

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Notes:

- Anyone interested in the segment calculation spreadsheet is welcome to e-mail Andy (acc1@andyscustomcraft.com) free of charge.

- Also, the next issue of *Woodturning Fundamentals* will include Andy Chen's follow-up article, Segmenting 201.