AN INTRODUCTION TO SEGMENTED WOODTURNING PART I

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ASSUMPTIONS MADE IN THIS PRESENTATION AND SOME PRELIMINARY OBSERVATIONS

- Throughout the presentation, you will see references to many fancy – and sometimes costly – gadgets, accessories and devices that make segmented turning easier and more accurate.
- But don't feel like you need to buy any of these just to give segmenting a try.
- This presentation assumes you just want to try it out without spending any significant amount of money on equipment or time in constructing fancy jigs or sleds.
- So it will be assumed that you will want to try it out using only basic shop equipment, such as a miter saw, or a miter gauge on your table saw or band saw. It will also be assumed that whatever equipment you are using is accurately set up.

OTHER PRELIMINARY NOTES

- It should be noted that there are many different ways to perform most of the steps illustrated here (i.e., ask 10 segmenters and you will get 10 completely different answers about why they believe their way is the "only" way to do something). The ones discussed below are simply what have worked for me. But you should use whatever techniques work best for you, given your experience, training, workstyle, skillset and available equipment.
- Who does segmented woodturning appeal to? Certainly not all turners. But for those who have a little patience and a desire to try something slightly different, it may be worth your time to explore this fascinating technique. Just know that once the segmenting bug bites you, it will likely become a lifelong addiction!

WHY TURN USING SEGMENTS?

1. No need to buy/scavenge large chunks of wood – you can make something amazing out of just small strips of wood from which you construct something much larger
2. No knots or voids to work around – unless you want to…….
3. Vastly increases your color options – you pick your colors, mix and match them as you please, and in the process create a piece that Mother Nature could not create on her own
4. Also vastly increases your shape options – you will only be limited by the capacity of your lathe and won't be limited by the shapes Mother Nature makes available to you
5. The use of feature rings and other design choices open up artistic options that would otherwise be almost impossible (for example, see Malcolm Tibbetts' work at immediate right)
6. You will also be able to avoid turning end grain entirely, since you will only be turning face grain in a segmented piece. This absence of any visible end grain can be very useful when making basket illusion pieces (far right)

WHY TURN USING SEGMENTS? (CONTINUED)

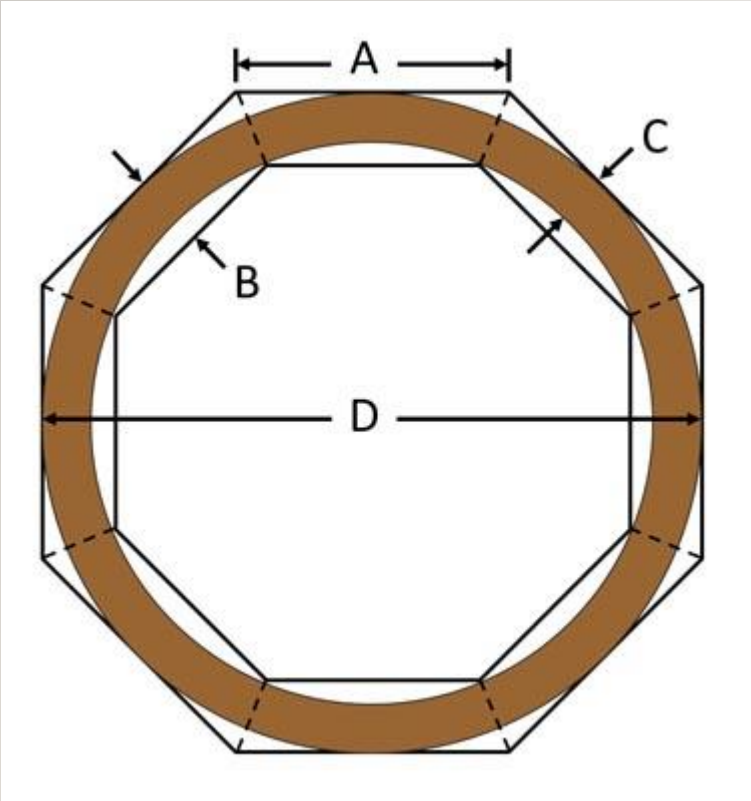
7. Another simple thing you can do using segmenting techniques – and what we will focus on in this first part of our presentation – is to make a single ring to accent the top of a solid wood bowl (below left). ***NOTE***: It is risky to add a segmented ring to the top of a solid wood bowl due to possible seasonal wood movement that may cause the joint between the solid bowl and the ring to fail. Malcolm Tibbetts does not recommend doing it. Other segmenters say they have done it many times without any joint failures. But just know that there is risk involved in doing this. Make sure all the wood you use in such a project is VERY dry.

8. Additionally, you could add a feature ring to accent the middle of a solid wood bowl (below middle), and/or make an accent disc to embed in the inside bottom of a solid (or segmented) wood bowl (below right).

WHAT EQUIPMENT DO I REALLY NEED?

- One can do quality segmented woodturning with only one piece of equipment other than a lathe – a decent quality table saw. A table saw is the much preferred tool for cutting the strips of wood that will be used for making the segments of a segmented ring. These strips can be cut on a bandsaw, but the results might not be as good as cutting them on a table saw.
- If you have a table saw in your shop, you can also use it to cut the segments using a miter gauge, as we will discuss in greater detail below.
- But if you don't have a table saw, you can cut the segments using your bandsaw or a miter saw, both of which methods will also be discussed in greater detail below.

WHAT IS A "SEGMENT"?



- For our purposes, a segment is a piece of a ring. Rings can be any practical size that you want, and you can make them out of pretty much any reasonable number of segments that you want. The major skill in segmented woodturning is learning how to cut segments of the correct segment length and at the precisely correct angle for whatever number of segments you decide to put in the ring.

WHY IS IT ESSENTIAL TO HAVE GREAT ACCURACY IN CUTTING SEGMENTS?

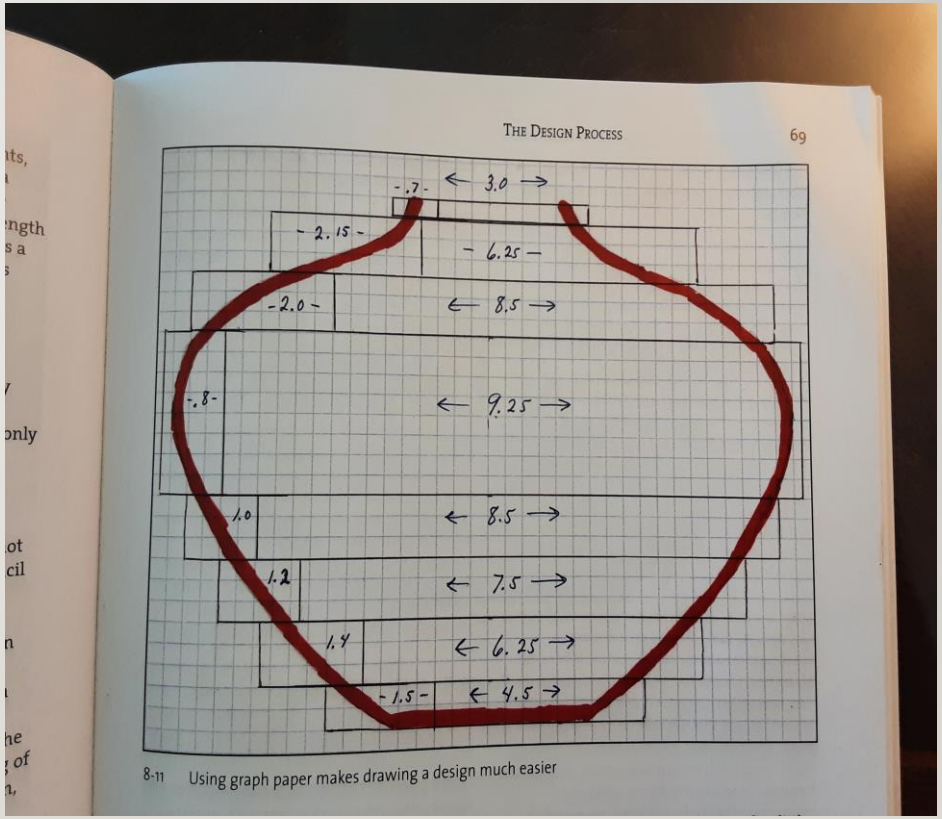
- Each segment has (for purposes relevant to the formation of a segmented ring) two cut edges on it: the left and right sides of the segment. So even a 5-segment ring has a total of 10 cut surfaces.
- So if there is even a 1 degree error in each cut, that means the total error in the whole ring could be as much as 1 x 10 = 10 degrees. And a 10 degree gap in the circle would be too great to allow the segments to form a perfect circle – which is the ultimate objective in this type of segmented turning.
- Imagine if you were using 48 segments per ring. That means 96 cut surfaces in the whole ring – and even a 0.25 degree error in each cut surface could result in as much as a ***24 degree*** gap in the ring!!
- So near-perfect accuracy will make it much easier to create tight rings with no visible gaps between segments. But don't worry too much - we will discuss below a technique to correct for inaccurately cut segments.

WOOD SELECTION

- One of the cardinal rules of segmented woodturning is: ***DO NOT USE GREEN WOOD!!*** Preferably, use only kiln-dried wood with known low moisture content. Steer clear of air-dried wood unless you have verified its low moisture content with a quality moisture meter. The use of any wood with elevated moisture content will likely lead to disastrous results in a segmented piece once it fully dries.
- Also avoid soft and open-grained woods (alder, ash, mahogany, poplar, oak, etc.) if possible unless color choice dictates otherwise. Hard, tight-grained woods (like bloodwood, bocote, bubinga, hard/curly maple, purpleheart, yellowheart, rosewood, etc.) are preferable. Birch, walnut, cherry and osage orange are decent as well.
- No matter what wood is selected, it is best to start with boards that are surfaced on all 4 sides (s4s), either by the vendor from whom you purchased it or done in your own shop prior to use for this purpose.

WIDTH OF WOOD STRIPS USED FOR CUTTING SEGMENTS

- The width of the wood strip that you will need will largely be determined by where the ring sits within your design. If it will be part of a fairly vertical portion of the bowl, you can make the strip rather narrow. But if it is part of a highly curved portion of the bowl, it will likely have to be much wider. See sketch at right for how width will vary depending on ring position. As this sketch shows, you will want to give yourself at least ¼" extra on both the inside and outside of each segment from the minimum width necessary to achieve the final thickness of the vessel within each ring.
- Also, width may be affected by a desire to provide yourself with design flexibility while turning – in other words, give yourself extra width to play with in case you want to alter your design as you turn.
- As you gain more experience in segmented turning, you will likely want to use one of the available computer programs to design your pieces. These programs will print out very specific lists of the recommended widths and lengths of the wood strips needed to build your piece, saving you from much guesswork – and cost.



LENGTH OF WOOD STRIPS FOR CUTTING SEGMENTS

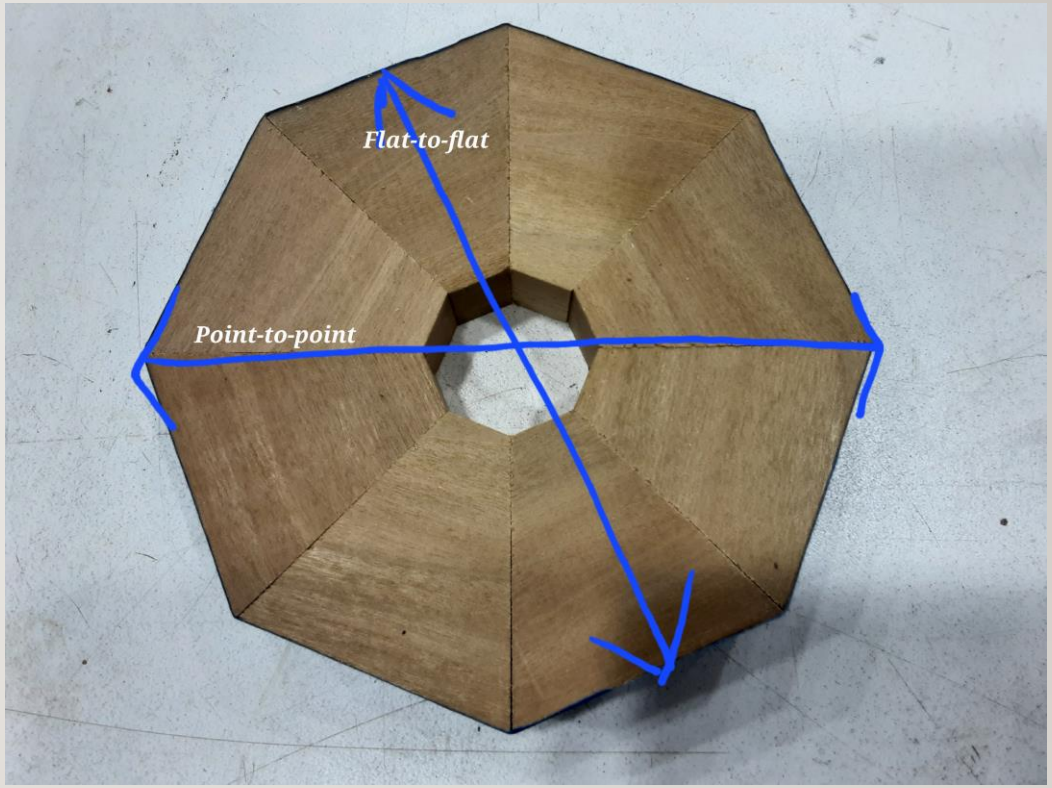
- In order to determine the length of the strip that you will need to cut the segments for a ring, you will first need to determine the *final* size that the ring needs to be.
- Looking at your graph paper design (such as on slide 10) will allow you to see the *approximate* size needed for each ring. But how does that translate into real-world ring construction – especially if you have not used a computer program that tells you exactly what size the pre-turning "rough" rings need to be?
- Your design will tell you what the *approximate* turned diameter of each ring needs to be. But the rough pre-turned rings you will make aren't rounded yet, so you need to make the rough ring somewhat larger than the needed *final* turned diameter.

DECIDING ON THE *FINAL* SIZE OF EACH RING

- How much larger, you ask? That somewhat depends on the number of segments you are using in each ring. For example, a ring with only 4 segments has very long "points" at each joint (the "point-to-point" diameter shown on slide 13), so you will need to make the rough ring a good bit larger so that you will end up with enough diameter left when the ring is finally turned round. But a ring with 48 segments starts out much closer to round already, so you don't need as much "extra" diameter in the rough ring. This "extra" amount is variously referred to as the "fudge" factor, or what I believe Malcolm Tibbetts has referred to as "padding."
- For what it is worth, I generally make rings of 12-20 segments and find that 3/8" is enough of an "add-on" to the rough ring size to give me the final turned diameter that I want. If your rings will be more in the 8-10 segment range, you may want to use ½". Similarly, you will find that rings of 24 segments or more are nearly round, so you need to add very little padding – maybe only 1/8".

EXPLANATION OF ROUGH VERSUS FINISHED RING SIZE

- The picture on the right shows two measurements: the "point-to-point" diameter of the ring (the "rough" ring size) and the "flat-to-flat" diameter – with the latter being the closest to the final (or "finished") diameter after rounding off the ring on the lathe.
- So if you wanted a ring with a final turned diameter of 6", and you used that diameter in the formula for calculating segment length (see slides 29 and 30), you would get a segment length of 2.36".
- But that segment length would only give you a ring with a "point-to-point" measurement of 6" – and that would be too small to leave 6" diameter after rounding the ring on the lathe.
- Hence the need for the ½" (since this is an 8-segment ring, or whatever other amount you want to use if you have more segments in your ring) add-on or "fudge factor." So you would use 6.5" as the diameter in the segment length formula, resulting in a segment length of 2.55" instead of 2.36".



DETERMINING THE LENGTH OF STRIPS FROM WHICH TO CUT SEGMENTS

- Now that you know what the final size of the ring should be, it is easy to calculate how long the strip needs to be from which you will cut the segments for the ring. Keep in mind that it is typically a good idea to cut all the segments for a ring from the same strip, since that will maximize the chances of ensuring uniform grain and color. Of course, there are practical limits on such length if using a table saw, but most typical rings will not require excessively long strips.
- To determine the length of the strip, simply add 5" to the circumference of the ring, since that will provide sufficient length to prevent your having to get too close to the blade with your final cuts.
- The *formula for determining the circumference of a ring* is:

  diameter times pi (3.14)

- So for an 8.5" ring, one should use a strip that is 5" + (8.5 × 3.14) or approximately 32"

DETERMINING HOW MANY SEGMENTS TO USE PER RING

- This is largely a function of your specific design, as well as your patience for cutting and gluing segments. Also relevant might be the limitations imposed by your available equipment: for example, what wedges you have if using a Wedgie sled, or, if using a MiterSet for Segments to set your miter gauge, the fact that it only provides settings for up to 20 segments per ring. And if you are using a miter saw, you may want to stick with the 15 or 22.5 degree fixed stops, meaning you are limited to 8 or 12 segments per ring.
- It might be helpful to look at examples of others' work in the many segmenting books on the market.
- Also, particularly useful are pictures in the many segmenting pages on Facebook, such as Segmented Bowl Turning or Segmented Turning Forum.
- Once you have decided on the number of segments per ring, it must be remembered that each change in the number of segments to be used in a ring impacts the setting of whatever device is being used to cut the segments.
- Also, remember that you can mix and match different color woods even within the same ring – and that not all the segments need to be the same length or miter angle as long as the miter angles of all segments add up to 360 degrees. (We'll assume for our discussion here, however, that nothing that fancy is being done just yet!)

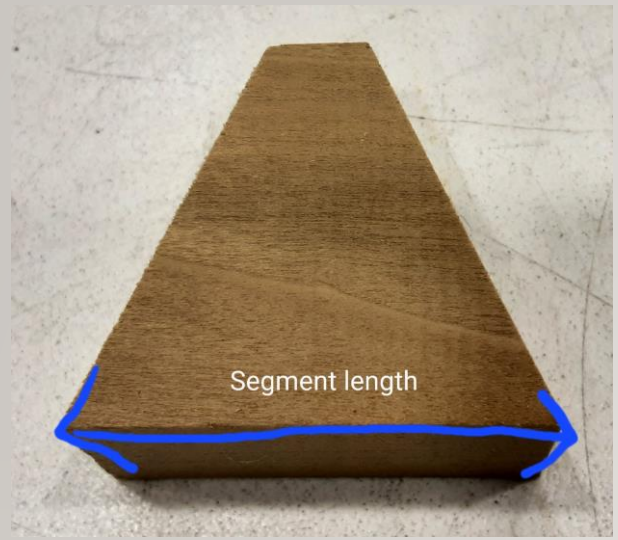
THE NUMBER OF SEGMENTS YOU SELECT FOR YOUR RING WILL DETERMINE THE CORRECT ANGLE FOR CUTTING THE SEGMENTS

- Before beginning to cut the segments, there is one additional number we need to know: what angle to use on our miter gauge or miter saw to cut our segments.
- The **formula to determine the miter angle** is quite simple and is based on the underlying concept that a full circle contains 360 degrees:

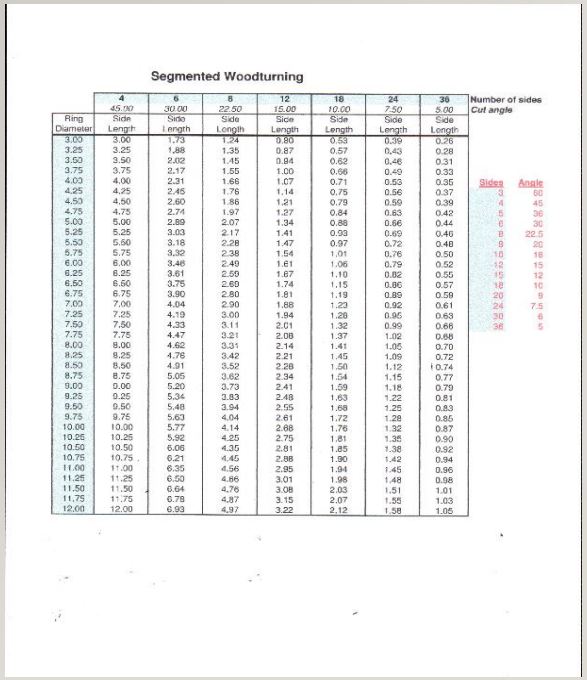
  360 degrees ÷ (2 times the number of segments you want in the ring) = miter angle

- So if you want 20 segments in each ring, then the angle at which you need to set your miter gauge would be:

  360 degrees ÷ (2 x 20) = 9 degrees



CALCULATION OF SEGMENT LENGTH



Segmented Woodturning

Ring Diameter	4 45.00 Side Length	6 30.00 Side Length	8 22.50 Side Length	12 15.00 Side Length	18 10.00 Side Length	24 7.50 Side Length	36 5.00 Side Length
3.00	3.00	1.73	1.24	0.80	0.53	0.39	0.26
3.25	3.25	1.88	1.35	0.87	0.57	0.43	0.28
3.50	3.50	2.02	1.45	0.94	0.62	0.46	0.31
3.75	3.75	2.17	1.55	1.00	0.66	0.49	0.33
4.00	4.00	2.31	1.66	1.07	0.71	0.52	0.35
4.25	4.25	2.45	1.76	1.14	0.75	0.56	0.37
4.50	4.50	2.60	1.86	1.21	0.79	0.59	0.39
4.75	4.75	2.74	1.97	1.27	0.84	0.63	0.42
5.00	5.00	2.89	2.07	1.34	0.88	0.66	0.44
5.25	5.25	3.03	2.17	1.41	0.93	0.69	0.46
5.50	5.50	3.18	2.28	1.47	0.97	0.72	0.48
5.75	5.75	3.32	2.38	1.54	1.01	0.76	0.50
6.00	6.00	3.46	2.49	1.61	1.06	0.79	0.52
6.25	6.25	3.61	2.59	1.67	1.10	0.82	0.55
6.50	6.50	3.75	2.69	1.74	1.15	0.86	0.57
6.75	6.75	3.90	2.80	1.81	1.19	0.89	0.59
7.00	7.00	4.04	2.90	1.88	1.23	0.92	0.61
7.25	7.25	4.19	3.00	1.94	1.28	0.95	0.63
7.50	7.50	4.33	3.11	2.01	1.32	0.99	0.66
7.75	7.75	4.47	3.21	2.08	1.37	1.02	0.68
8.00	8.00	4.62	3.31	2.14	1.41	1.05	0.70
8.25	8.25	4.76	3.42	2.21	1.45	1.09	0.72
8.50	8.50	4.91	3.52	2.28	1.50	1.12	0.74
8.75	8.75	5.05	3.62	2.34	1.54	1.15	0.77
9.00	9.00	5.20	3.73	2.41	1.59	1.18	0.79
9.25	9.25	5.34	3.83	2.48	1.63	1.22	0.81
9.50	9.50	5.48	3.94	2.55	1.68	1.25	0.83
9.75	9.75	5.63	4.04	2.61	1.72	1.28	0.85
10.00	10.00	5.77	4.14	2.68	1.76	1.32	0.87
10.25	10.25	5.92	4.25	2.75	1.81	1.35	0.90
10.50	10.50	6.06	4.35	2.81	1.85	1.38	0.92
10.75	10.75	6.21	4.45	2.88	1.90	1.42	0.94
11.00	11.00	6.35	4.56	2.95	1.94	1.45	0.96
11.25	11.25	6.50	4.66	3.01	1.98	1.48	0.98
11.50	11.50	6.64	4.76	3.08	2.03	1.51	1.01
11.75	11.75	6.78	4.87	3.15	2.07	1.55	1.03
12.00	12.00	6.93	4.97	3.22	2.12	1.58	1.05

Number of sides / Cut angle

Sides	Angle
3	60
4	45
5	36
6	30
8	22.5
9	20
10	18
12	15
15	12
18	10
20	9
24	7.5
30	6
36	5

- Once you know your desired rough ring size (including the "fudge factor" or "padding"), have decided on the number of segments you want per ring, and have adjusted your equipment to the correct miter angle for the number of segments that you want in each ring, you need to determine the exact "length" that each segment needs to be in order to end up with the correct size of ring. The blue arrow in the picture at upper left is the "segment length".
- One method to determine segment length would be to use one of the charts readily available on the internet that lists segment lengths for certain specific ring diameters. The sample chart at lower left builds in a certain "fudge factor" so that the ring will be roughly the listed size after turning round. The segmenting computer programs previously mentioned will also determine the correct segment length for you, using whatever algorithm the author selected for determining the "fudge factor."
- Another method to determine segment length would be to use the **standard <u>formula for determining segment length</u>:**

  Diameter of ring x 3.14 (pi) ÷ number of segments in ring = segment length

  (The mathematicians out there will know that there is a trigonometric formula – involving tangents and the like - that can be used to provide a more precise segment length without including a "fudge" factor (discussed below), but my brain hurts even thinking about that. The computer design programs mentioned above build these formulas into their calculations so that the materials lists are as accurate and cost-effective as possible.)
- Let's assume we want an 8 3/8" rough ring diameter and that we want 20 segments per ring. So the **<u>formula for determining segment length</u>** in that case would be:

  (rough ring diameter times pi) divided by number of segments in the ring = segment length.

  (8.375 x 3.14) ÷ 20 =1.316"
- So **<u>segment length</u>** in this case would be 1.316"

THERE ARE MANY WAYS TO CUT SEGMENTS

- On the *table saw* (this assumes the use of a quality crosscut or combination blade that is accurately adjusted to be parallel to the miter slot and 90 degrees to the table top, and that whatever device listed below is used in the miter slot is adjusted so that there is no "slop" in the movement along the slot):
  - Using a shop-made Wedgie sled (can produce rings of any number of segments for which you can buy or make an accurate wedge)
  - Using a Wedgie-less sled (can produce rings of 10, 12, 16, 20, 24, 36, 48, 72 and 144 segments – and can use wedges for wedgie sleds for additional options)
  - Using a Miter gauge – can be set in a variety of ways to ensure the necessary accuracy:
    - With a quality drafting triangle (can be accurate but very limited number of ring segment options)
    - With digital protractor (can produce rings with any number of segments)
    - With a MiterSet for Segments device (can produce rings with up to 20 segments)
    - With vernier scale (high-end gauges) (can produce rings with any number of segments)
    - With Rockler-type blocks (can produce rings from 4-12 segments)
- *Band saw* – again, this assumes the use of a quality blade and that the saw is properly adjusted and the blade properly tensioned.
- *Miter saw* – this is the technique preferred in many instances by such segmenting luminaries as Malcolm Tibbetts. It also assumes the use of a quality crosscut blade and that the saw is properly set up so that the blade is 90 degrees to the base and the fence so that the fixed stops will be accurate.

TABLE SAW – USING A SHOP-MADE WEDGIE SLED

Check out the YouTube videos from Jerry Bennett on how to build and use this sled. Links to these videos – and detailed plans on how to make the sled – are available on his website : Segeasy.com

And go to Segeasy.com to purchase wedges for setting the jig accurately - or find a friend with a 3-D printer since files for printing these wedges are widely available on the internet.

A downside to this method is that the commercial wedges cost around $13 for each size. That can get costly if you use a wide variety of ring segment sizes.

However, an upside is that the sled will give you options that a miter gauge won't – such as complementary segments and complementary pairs (see Jerry's videos for discussions of these).

Another advantage of using a wedgie sled is that the wood strips used for your segments do not get flipped over when cutting successive segments. This allows you to achieve greater color/grain consistency (if that is important for your piece (it usually isn't for me….)) as long as you number each segment as it is cut and then align them numerically around the ring as you assemble it.

TABLE SAW – USING A SHOP-MADE WEDGIE SLED PART 2

The sled and zero clearance cutoff ramp

Optional flipper system instead of cutoff ramp

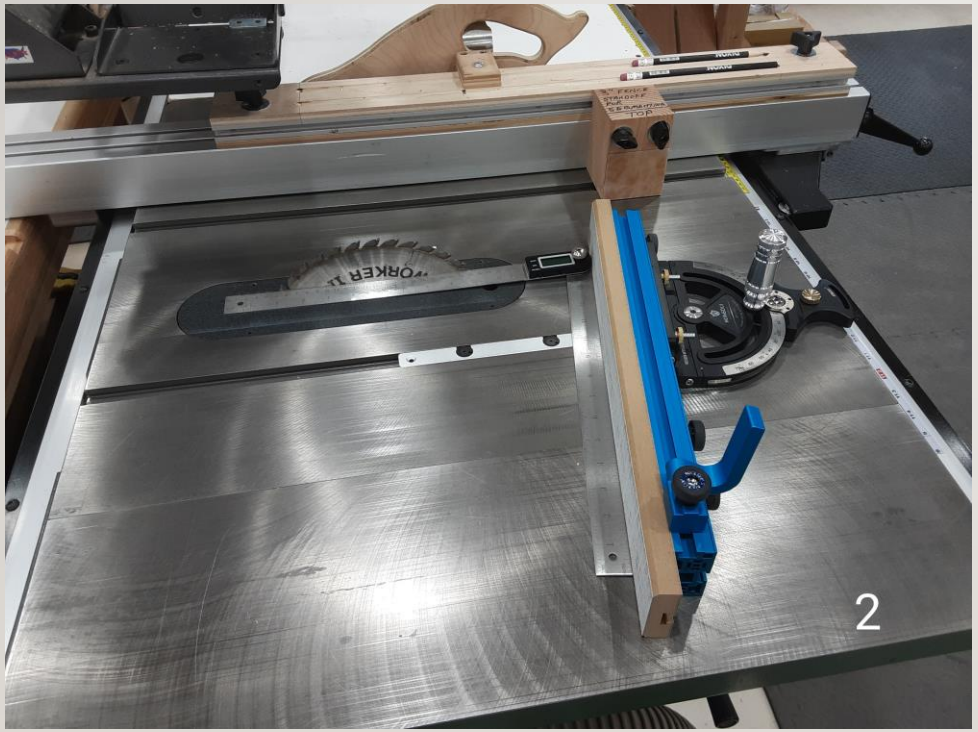
The adjustable stop

TABLE SAW – USING A COMMERCIAL WEDGIE-LESS SLED

This version does not need wedges since it can be very accurately set to around 9 different segment ring sizes, the settings for which have been CNC machined onto the sled itself. (Note: you can also use wedges to set the fences for segment ring sizes other than those machined onto the sled.)

Available from petemarkenwoodturning.com. Sled on left side is around $175 and optional cutoff table on right side with stop block is around $165.

TABLE SAW – USING A MITER GAUGE SET WITH A DIGITAL PROTRACTOR



When using any miter gauge for cutting segments, it is advisable to add a sacrificial auxiliary fence that has a piece of sandpaper glued onto it. This will reduce the likelihood of finger pressure on the wood strip affecting the consistency of the repetitive cuts necessary for segmenting, as your wood strips may have a tendency to slide when held against the original factory fence.

TABLE SAW – USING A MITER GAUGE SET WITH A MITERSET FOR SEGMENTS

This device allows very rapid and exceedingly accurate setup of a miter gauge for rings from 4 to 20 segments. Its cost (around $100) is significantly less than the cost of all the Wedgies that it replaces. The website for the manufacturer is MiterSet.com.

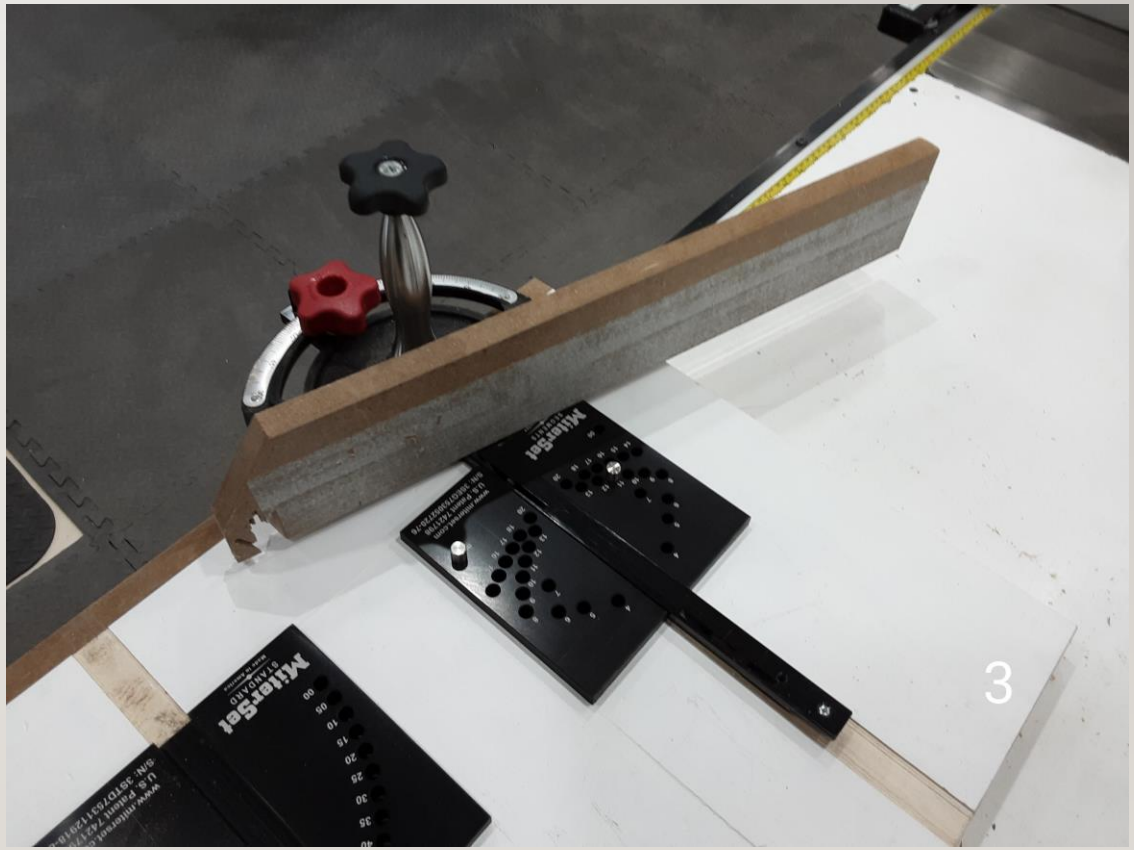
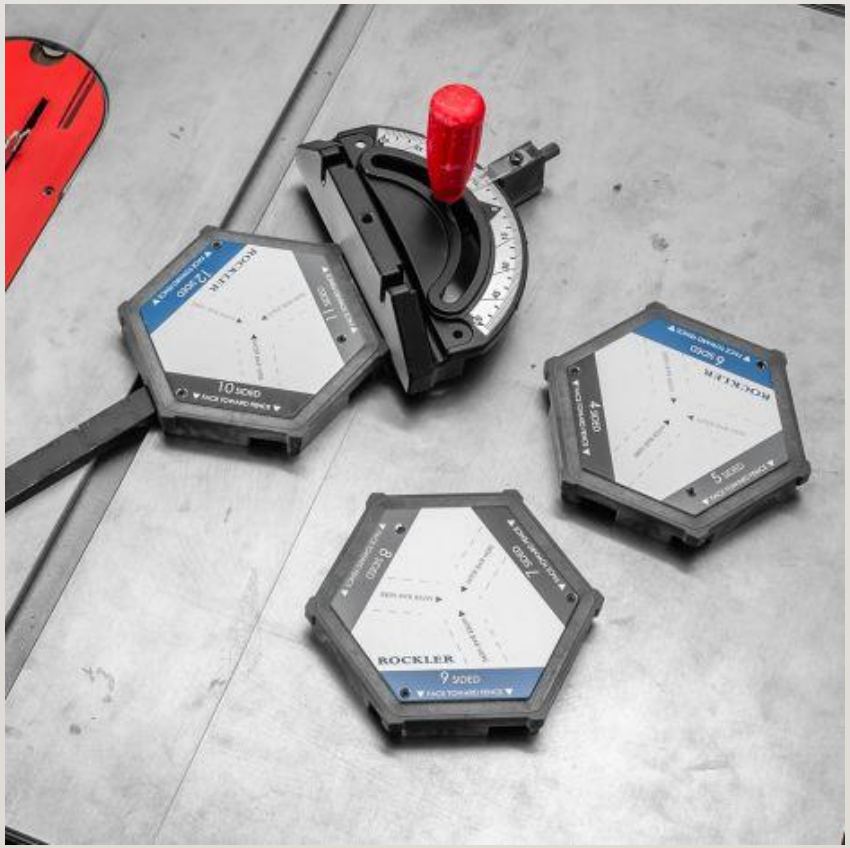


TABLE SAW – USING A HIGH-END MITER GAUGE SET WITH VERNIER SCALE ON THE GAUGE ITSELF

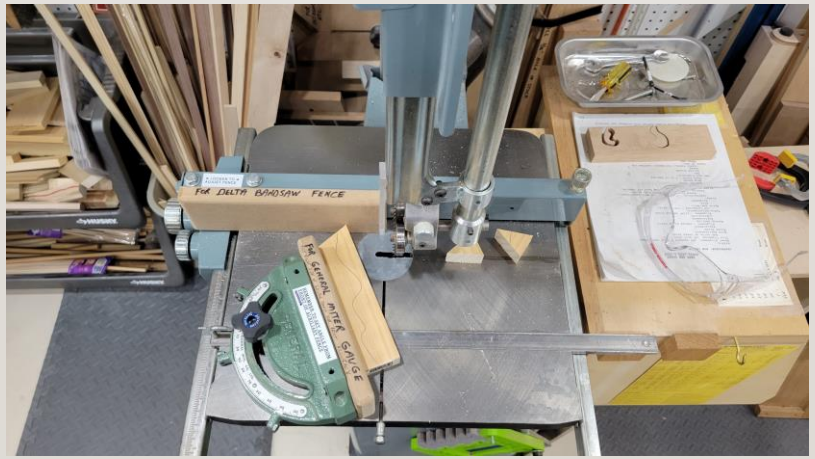
TABLE SAW – USING A MITER GAUGE SET WITH ROCKLER-TYPE BLOCKS



BAND SAW

You can cut segments several different ways on a bandsaw. First, of course, you must ensure that you are using a quality blade and that your blade is 90 degrees to your table and is properly tensioned. Then, here are some setup possibilities:

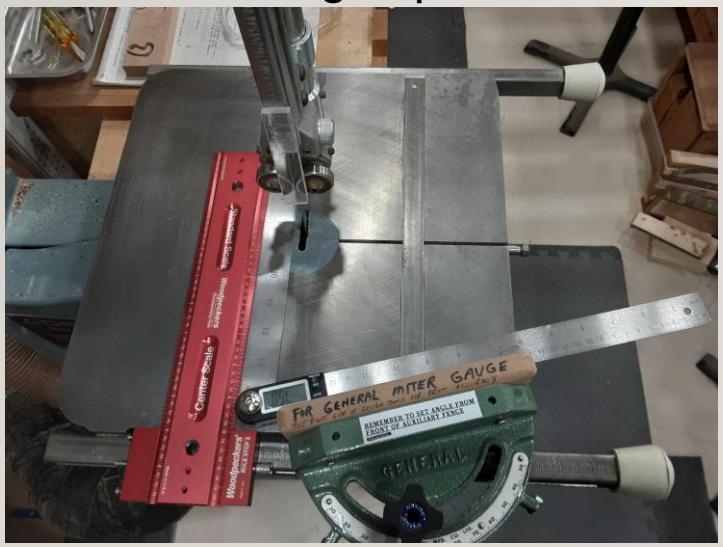
1. Build a sled yourself (for wedges or a fixed angle version)
2. Use a miter gauge and stop (but, as with all these sleds, make sure your miter gauge fits tightly in the table slot and is accurately set to the correct angle)
3. Buy a commercial sled such as the Accu-Wedge/Accu-Slice system from accu-slice.com. Cost begins around $750.



SETTING UP A MITER GAUGE ON THE BANDSAW FOR SEGMENTING

- If you opt to use your bandsaw for cutting segments, remember that, as with any segmenting work involving the use of a miter gauge, it is imperative that it be set up accurately to ensure gap-free rings. There are a couple good ways to do this:

Use a digital protractor

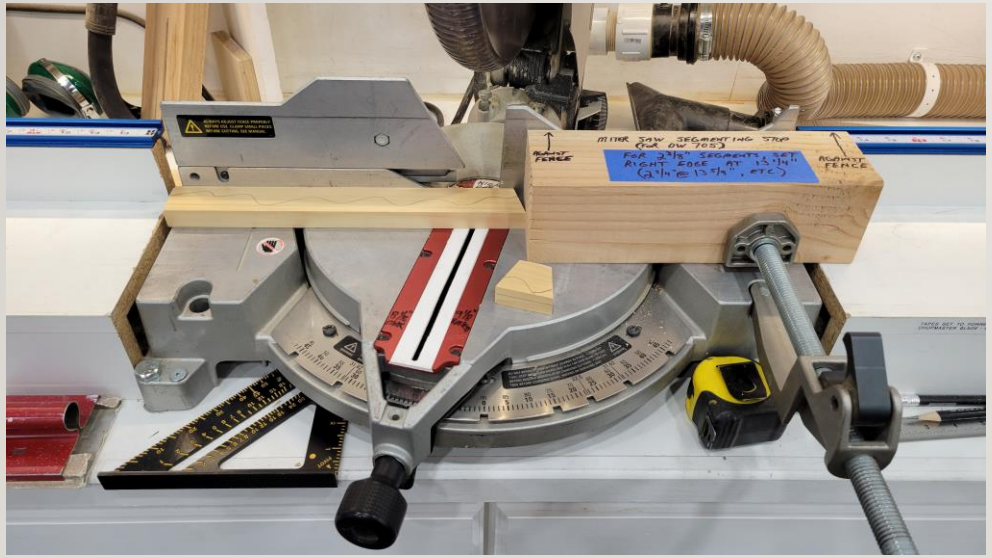


Use a wedge

Use a MiterSet for Segments

MITER SAW

Malcom Tibbetts (one of the experts in the field of segmented turning) discusses the use of the miter saw for this purpose in his outstanding book titled "The Art of Segmented Woodturning," which is a strongly recommended purchase if you intend to get serious about segmenting. Here are two different techniques for cutting segments on the band saw.



SETTING UP A MITER SAW FOR SEGMENTING

- As with any other method for cutting segments, accuracy in your setup is critical. If using a miter saw, start out by making sure that you use a quality crosscut blade that is exactly 90 degrees to both the base and the fence. Then consider one of these methods to set it up accurately for cutting segments:
  - Use one of the fixed stops on the saw – as a practical matter, however, this really only applies to either the 15 degree stop on most miter saws (which will give you a 12-segment ring) or the 22.5 degree stop (which will give you an 8-segment ring). None of the other fixed stops on most miter saws translate to the correct degree setting for ring segments. Note that these stops will not be accurate if your initial setup is done incorrectly. And it is always advisable to verify those stops by checking with a wedge or protractor.
  - Use a commercial wedge
  - Use a digital protractor

HOW TO CUT SEGMENTS OF CORRECT LENGTH

- You could use the "stop" illustrated in the Wedgie sled (slide 11) above – simply adjust the stop towards or away from the blade in small increments until the desired segment length is achieved. *(Note: it is best to use a digital caliper to measure segment length – not a ruler or tape measure.)*
- Or, if using a miter gauge setup, use a stop clamped to your table saw or band saw fence (photo at right) and then adjust the fence to get the desired segment length. *(Note: I use a shop-built micro adjuster (fancy name for a block with a screw through it) on my fence rail to facilitate the making of tiny adjustments.)*
- *NOTE: Do not drive yourself crazy here trying to get the segment length correct to the hundredth of an inch. A few hundredths variation in the segment length will not significantly affect the ring size.*

BEGINNING CONSTRUCTION

- Once you have decided on a design and determined the thicknesses and widths of the strips to be used, many segmenters follow the recommendation by Jerry Bennett, designer of the wedgie sled, to draw a squiggly line down one of the faces of each strip and a straight line down one edge of the strip (*don't worry – none of these lines will be visible on your final product!*). Keeping the faces of the cut segments with the squiggly line up help to keep the grain direction oriented correctly. And alternating the cut pieces with a straight line on the inside and the next one on the outside (see discussion on slide 34) corrects for any error that might exist in your blade being exactly 90 degrees to the table saw top, or band saw table, miter saw base, etc. (i.e., error in blade verticality).

CUTTING THE SEGMENTS

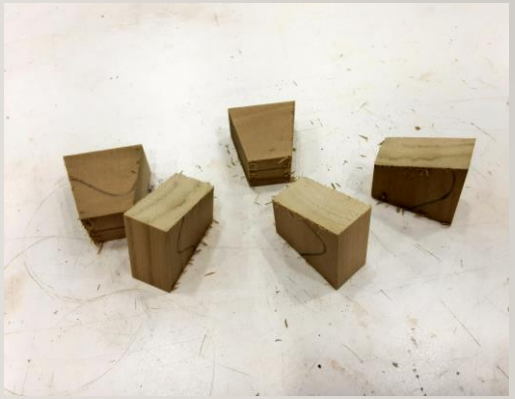
- Once you have decided on what method to use to cut your segments, how many segments per ring, etc, and you have accurately adjusted whatever tools are being used, then begin cutting your segments. Shown here is a fairly simple setup using a miter gauge and a stop block attached to the table saw fence.

CUTTING THE SEGMENTS PART 2

- Begin by cutting off the squared end of your strip – this will leave the correct angle on one side of what will be your first segment.
- Then flip the strip over, hold the "pointed" end tight against your stop and cut the first segment. Make sure the wood strip does not move at all once you have it set against the stop – use consistent finger pressure to hold it against the fence, and hold it as close to the blade end of the fence as you are comfortable doing in order to eliminate error that might result from a slight warp in the strip that could flex it away from the face of the miter gauge.
- Continue flipping over the strip each time and cutting segments until you have enough to complete your ring.
- Each segment will have part of your "squiggle" line on one face and straight line on one edge, which becomes relevant in the assembly step.

ASSEMBLING THE RING

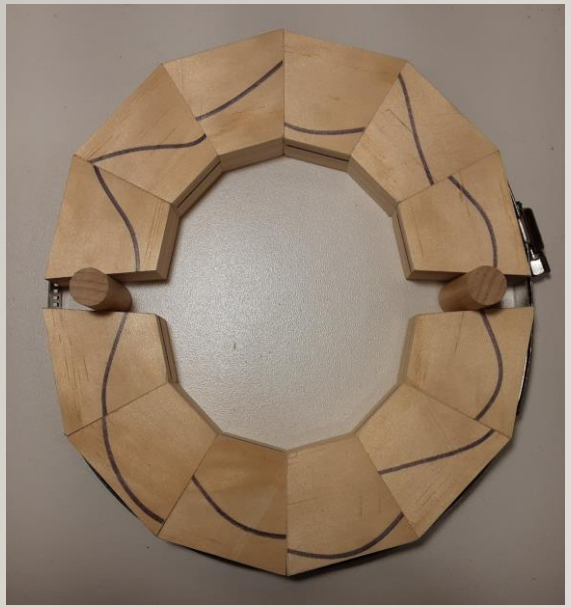
- The next step is to sand the "fuzzies" off each segment to ensure nothing gets in the way of tight joints once the ring is glued and clamped. A small hand sander works great for this purpose.
- Then do a dry assembly to make sure the cuts were sufficiently accurate to give you a tight ring with no gaps. This should be done prior to any gluing or clamping. Arrange the segments so that all faces with squiggly lines are up, but alternate segments with the straight line on the inside edge, and the next one with the straight line on the outside edge, since this will minimize any error in the blade being 90 degrees to the table saw top. (See photo on slide #35)*(Note: this same orientation of the segments should be followed even if they are cut on a wedgie sled – despite the fact that the strips are not flipped during the cutting process using such sleds) (Further note: alternating segments in this fashion usually ensures consistent grain direction – but if the grain in your strip would give undesirable results if cut in that fashion, you will have to use a different cutting technique that does not involve flipping the strip, but this generally would necessitate a much longer strip since there will be considerably more waste).*



ASSEMBLING THE RING PART 2

- To temporarily hold the segments in a circle to test for the accuracy of the cuts, I use zip ties since they are cheap, easy to use, provide enough clamping pressure to test for gaps, and can be reused many, many times. Many segmenters use rubber bands for this purpose, but they can be hard to use on larger rings unless you build a special jig for that purpose.
- When testing the fit of your cuts, do not depend on clamping pressure to "close gaps." If you do, those joints will likely fail in the future.

METHODS TO CORRECT INACCURATE WEDGES



- Some segmented turners use different techniques to "correct" wedges that are not as accurate as they need to be:
  - Painstakingly sanding each wedge using a jig on a disc sander, etc. This takes time and patience, of course, but can result in very accurate rings (see Tibbetts' book for an explanation of the jig to use for this purpose).
  - If you simply cannot get the segments cut with enough accuracy to eliminate gaps between all the segments but don't want to sand each segment, consider gluing the ring one-half at a time and using round spacers between the halves while clamping (see picture at upper left). When the glue has dried, you would then sand each half on a disc sander (or sanding disc on your lathe as shown at lower left) until they can be joined in the center without a gap.
    - The problem with this method, of course, is that the joints will likely never line up vertically correct all around the piece since it is virtually impossible to sand all the halves the exact same amount. Fortunately, there are so many joints in a segmented piece that few people (besides other segmented turners) are ever likely to notice.

GLUING A FULL RING ALL AT ONE TIME

- If you are satisfied that the segments were cut with sufficient accuracy to result in a tight ring with no gaps, the next step is to glue and clamp the ring.
- Segmenters use many different methods to glue segments together – and which is best is really up to you. Many simply glue two pieces at a time (using the traditional "rub" technique and then holding the pieces together for 5 seconds or more) and placing them on wax paper or other stick-free surface and then using the same technique to add additional pairs until the ring is completed.
- I like to use the "blue tape" method, which involves laying out a length of blue painter's tape (preferably of a thinner width than the thickness of your segments) on the worktable with the sticky side up and then carefully placing each segment on the tape in the order and orientation that provided the tight dry-test ring, ensuring that the long point of each segment is tight against the segment next to it. I have had no issues using this technique in gluing rings up to 24 segments all at one time without the need to do pairs first.

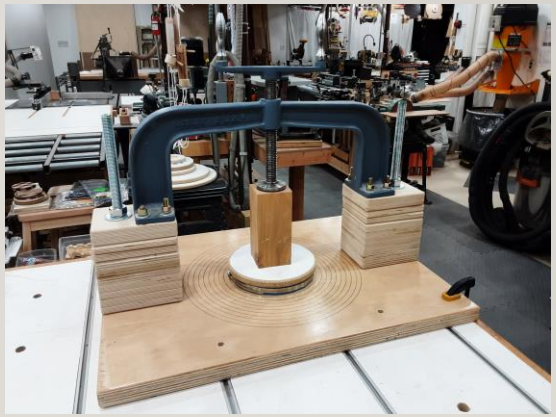
GLUING THE RING PART 2

- Then apply wood glue (I prefer Titebond III Ultimate because of its longer 8-10 minute open working time but any quality wood glue is fine for this purpose) to all the mating surfaces (I drip some into each joint and then quickly spread it with a glue brush). There is no need to go crazy with the amount of glue used – unless you own stock in the glue company, of course. For rings with very large numbers of segments, you may want to consider using something like Elmer's Glue-All since it has a much longer open time (35+ minutes in ideal conditions) than TBIII, or even than TB Extend.
- Once the ring is assembled and glued in that manner, I tear off the extra tape on one end so it is even with the edge of the first segment, then flip the taped assembly flat onto the worktable (ensuring the side on which you aligned the wedges is down), pull it tightly together and use the extra tape on the opposite end to temporarily hold the ring together as tightly as possible.

Titebond ORIGINAL Good	Titebond PREMIUM Better	Titebond ULTIMATE Best
TYPE Aliphatic Resin	TYPE Cross-linking PVA	TYPE Proprietary Polymer
STRENGTH 3,600 psi	STRENGTH 3,750	STRENGTH 4,000 psi
CHALK TEMPERATURE ≥ 50°F	CHALK TEMPERATURE ≥ 55°F	CHALK TEMPERATURE ≥ 47°F
SHELF LIFE 2 years	SHELF LIFE 2 years	SHELF LIFE 2 years
DRIED FILM Yellow	DRIED FILM Orange	DRIED FILM Light Brown
CLEANUP Water	CLEANUP Water	CLEANUP Water
VOC 10.7 g/L	VOC 3.0 g/L	VOC 9.0 g/L
OPEN/TOTAL ASSEMBLY TIME 4-6/10-15 minutes	OPEN/TOTAL ASSEMBLY TIME 3-5/10-15 minutes	OPEN/TOTAL ASSEMBLY TIME 8-10/20-25 minutes

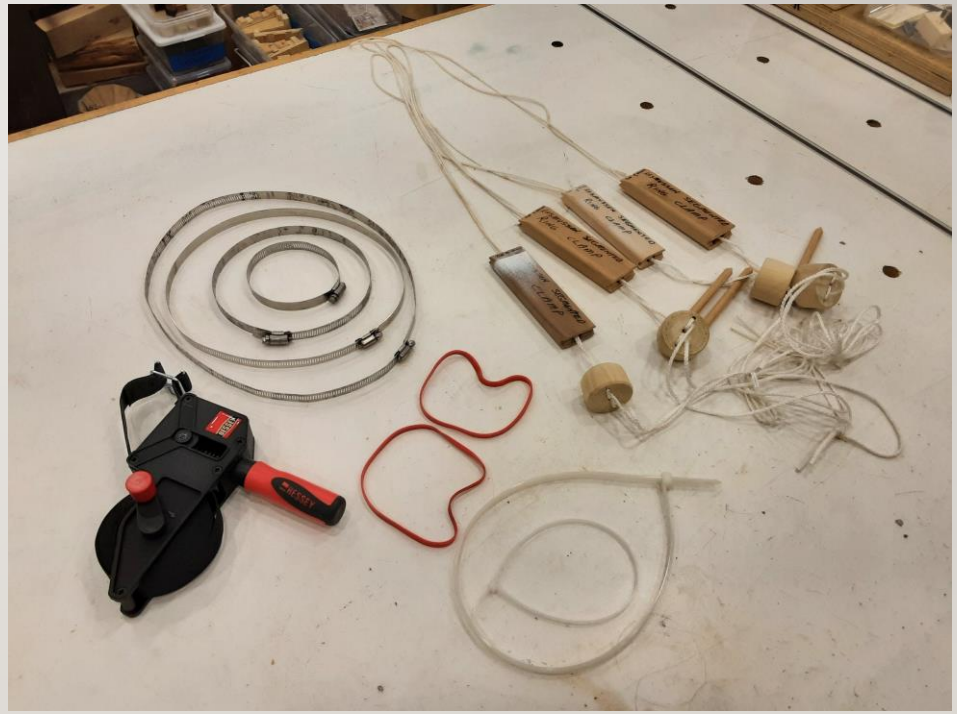
CLAMPING THE RING

- Then I immediately install a hose clamp around the ring (over the blue tape) and tighten it. There is no need to apply significant pressure with the hose clamp. You do not want to close gaps in your miter joints using excessive clamping pressure since that will likely result in future joint failure. You just want enough clamping pressure to squeeze out the excess glue without starving the glue joint (remember, you are gluing end grain to end grain here).
- As I am tightening the hose clamp, I try to ensure the segments stay in close alignment all the way around the ring. Then I use a rubber mallet to tamp down each of the joints to try to ensure all segments are as flat against the work surface as possible.
- Many segmenters don't do this next step (and some even argue against doing it), but, if the ring has segments of all the same height, I prefer to immediately place the ring in my press clamp for a few minutes so it will begin to dry as close to flat as possible. In my experience, this minimizes the amount of time and effort necessary to sand or turn the ring flat on both sides. Just make sure whatever pressure plate you are using has a non-stick surface – or place plastic wrap between the ring and your plate.



OTHER CLAMPING OPTIONS

- Not all turners have hose clamps large enough to use on segmented rings. You can generally connect them together to make a larger hose clamp that will work for you. But some folks may not have any hose clamps at all.
- Some other clamping options you might want to explore could include:
  - *Rubber bands* – but generally these will not provide sufficient clamping pressure to tighten the joints as much as you really want for a segmented ring
  - *Zip ties* – these are much better than rubber bands and can be re-used many times (and can be "strung" together to make virtually any ring clamp size) – but they still do not provide the ideal amount of even clamping pressure
  - *Rasmussen clamps* – these are the "rope" clamps shown at right. They provide more than sufficient clamping pressure but can be a little cumbersome to use
  - *Strap (or band) clamps* – many woodworkers have these in their shops so they may be a viable option for you, especially if you are gluing particularly thick rings.
  - *Bungee cord* – some turners buy bulk bungee cord and make their own adjustable clamps by tying a taut-line hitch on one end.



FLATTENING THE GLUED RINGS

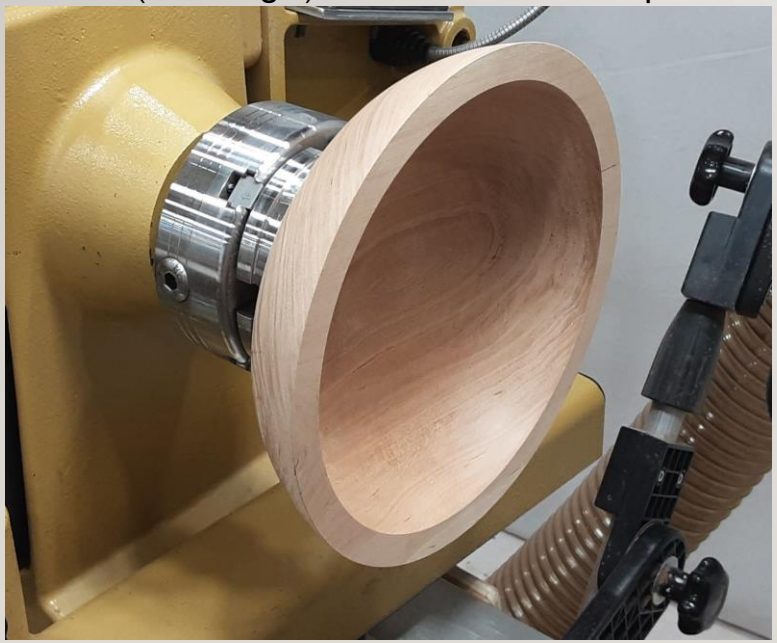
- This is a critical step that can lead to poor results in the final product if done incorrectly.
- There are several ways to flatten the rings:
  - By far the easiest method – and the one that provides the best results – is to use a *drum sander*. A drum sander allows each of the rings to be sanded to the same exact thickness (if that is what your project calls for). But not many hobbyist shops have such a pricey piece of equipment.

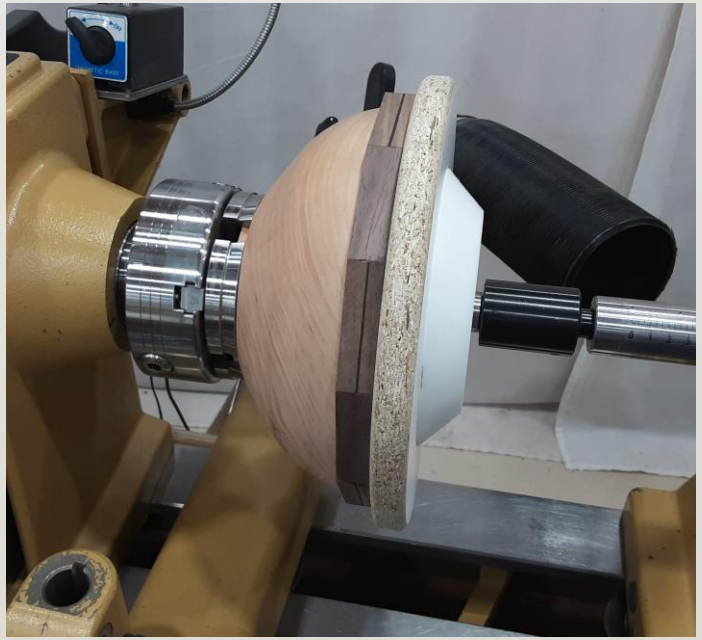
FLATTENING THE GLUED RINGS PART 2

- So an alternative method is to hold the ring against a *disc sander* (either a standalone sander or a disc mounted on your lathe) and flatten one side. Then the ring is glued in place on your project, with the unsanded side of the ring facing out. Once the glue dries, you can turn the unsanded side flat (using a bowl gouge and a large flat sanding plate) to prepare for the next ring if you are doing a fully segmented bowl or other vessel (which we will address in Part 2 of this presentation), or just shape the ring as desired if simply adding a single ring as an accent to the top of a solid wood bowl (which is discussed below).
- Some segmenters try to sand the rings flat with a *belt sander*, but this method generally leads to very inconsistent results. But I guess one uses what one has….

ADDING A SINGLE ACCENT RING TO THE TOP OF A SOLID WOOD BOWL

- When adding an accent ring to a solid wood bowl, it is probably best to begin the accent process with a somewhat rough-turned bowl, since the final shaping of the accent ring may impact how you ultimately want your piece to look. Once your bowl has been prepared (below left), and the inside of your ring has been sanded flat, the next step is to glue the ring to your bowl (below middle). After the glue dries, turn the ring to the desired shape and complete the turning and finishing of your bowl (below right). You are now an accomplished segmenter!!





The Finished Piece!!

For easy future reference, here is a summary of the three main formulas that we discussed in this presentation:

Formula to determine the circumference of a ring is:

Diameter of ring times pi (3.14)

Formula to determine the miter angle is:

360 degrees ÷ (2 times the number of segments in ring)

Formula to determine segment length is:

(Diameter of ring times pi (3.14)) ÷ number of segments in ring