Building and Turning a Segmented Bowl: The "Brick Bowl"

Russell G. Brown

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1 Introduction

This article is intended to serve two purposes. One is to provide a general introduction to the turning of segmented bowls. The other is a specific project, the "brick bowl" depicted in Figure 1. The brick bowl is perhaps a bit ambitious for a first segmented bowl project, but is complicated enough to show much of the technique needed to make a fine-craft or near-art-quality bowl. To the good, though, all of the cuts and construction techniques are relatively straightforward. If you can make it through the brick bowl with your sanity and love for woodturning intact, then you're pretty close to ready for the big-time.

Like swimming in cool water, the best way to get used to segmented bowl turning is to jump right in. The following two sections are an almost ridiculously thorough play-by-play of the construction and turning of the brick bowl. The section following that describes how to determine the sizes and shapes of the pieces you will need to build a segmented bowl of your own design.

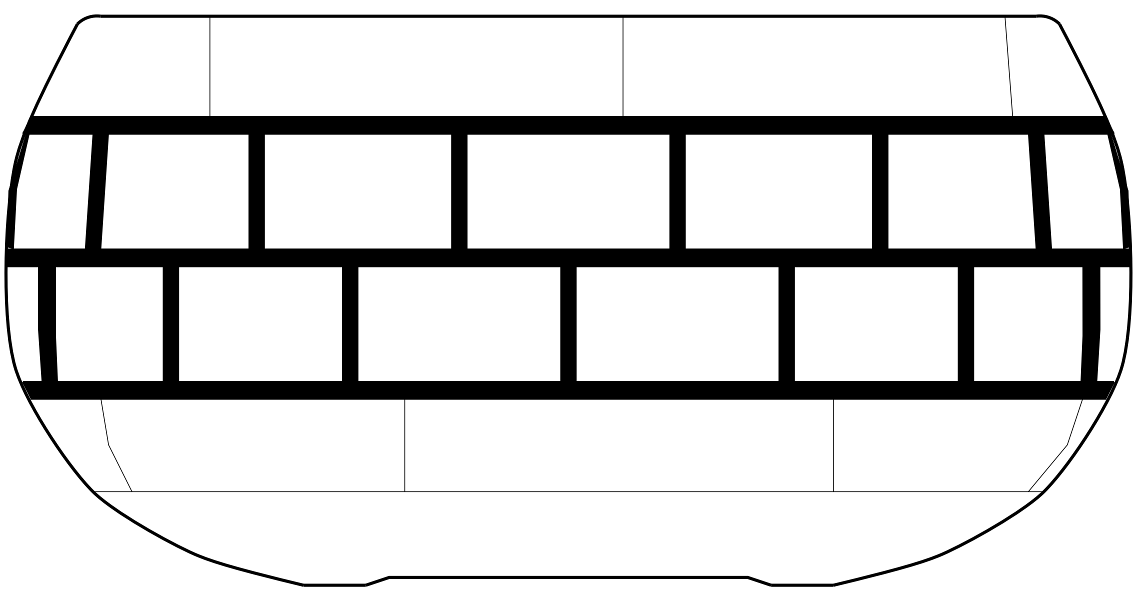
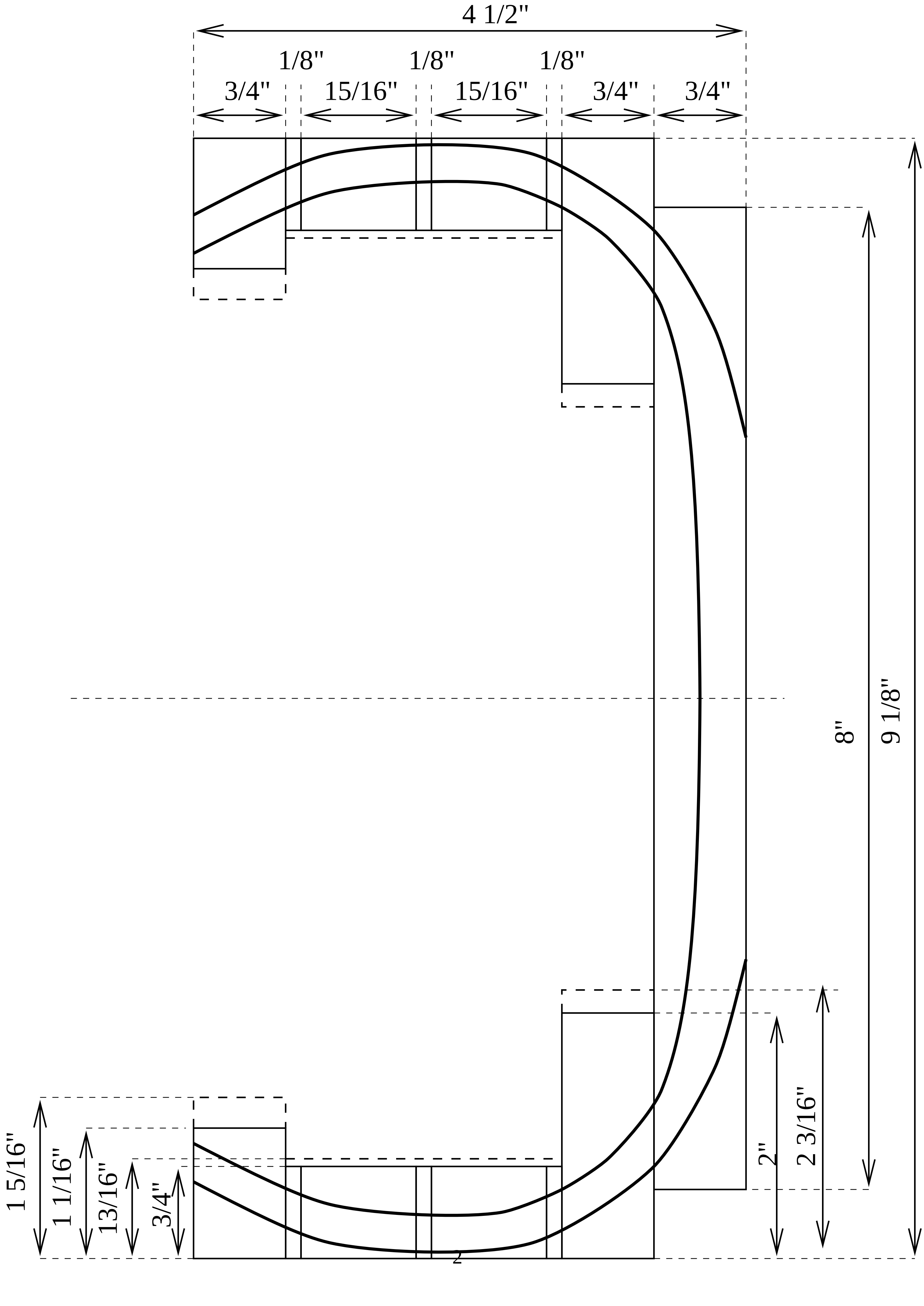


Figure 1: An artist's rendering of the brick bowl we describe how to build in this article.


4 1/2"
1/8"
1/8"
1/8"
3/4"
15/16"
15/16"
3/4"
3/4"
8"
9 1/8"
2"
2 3/16"
1 5/16"
1 1/16"
13/16"
3/4"

One treatment of this uses a fair amount of math, but a second treatment uses a couple of tables and minimal arithmetic. Hopefully it's enough to demystify the process.

A note on safely turning segmented bowls: I recommend wearing work gloves for much of the turning process. The same thing that makes segmented work easy to turn without lots of tearout also makes the half-turned blank a potentially painful porcupine of occasionally egregious splinters. Actually, for tool-control purposes, I will often wear a work glove on one hand. For most purposes, this will be the hand that's holding the front end of the tool, but occasionally it will be the hand that's holding the spinning bowl, or a part thereof. Eye and breathing protection is an absolute necessity, and if you want to keep your spouse from killing you, I recommend a lab coat or comparable body covering to keep most of the dust and shavings generated off of your clothing. Check this garment at the door.

Enough preliminaries, though: Let's see about this brick bowl. Good luck, and good turning!

2 Steps to Building the "Brick Bowl"

In this section, all sizes are stated outright. The method for determining them for a bowl of your own design is described in a later section.

1. Species selection: Pick three contrasting species of wood from which to build the bowl. The "mortar" species needs to be quite different in color from the "brick" species and the "bowl" species, but the brick and bowl species can be similar in coloration. I've had good luck with padauk/maple/walnut for brick/mortar/bowl, and also with maple/purpleheart/mahogany. It's important to choose species that won't fade to the same color with time and sunlight.

2. Stock selection: For the bowl dimensions used in figure 1 (9 1/8" diameter by 4 1/2" high), you will need an 8" solid square of the bowl species for the base, a stick of the bowl species at least 26" long by 2 3/16" wide for the lower 8-sided ring, and a stick of the bowl species at least 29" long by 1 5/16" wide for the upper 8-sided ring. You will also need a piece of the mortar species at least 30" long by 1" wide for the narrow rings (Note: this width assumes a 1/8" parting tool. If you have a 1/16" parting tool, it can be 3/4" wide, but it must be 1 1/4" if you have to use a 3/16" parting tool.) and a piece of the mortar species 2 1/4" long by 5" wide for the vertical pieces. You'll need a piece of the brick species at least 30" long by 2 1/4" wide. All of these pieces are 4/4 lumber. Finally, you'll need a 6" square of scrap to attach the bowl to your faceplate, and some pieces of straight-sided scrap approximately 1 1/2" to 2" wide to cut test pieces to check the blade's angle adjustment before you cut your wedges.

3. Cutting: Rip all of the pieces described in the previous step to the widths specified. Cut the small pieces (segments and flat pieces) for the segmented rings as follows:

1. **Mortar Slices —** attach an auxiliary fence to the mitre gauge for your table saw. The piece should be at least 3" high and extend about 6" past the blade. Set the blade height at roughly 1 1/4" and ensure that it is set perpendicular to the saw table. Clamp or screw a scrap block to the auxiliary fence 1/8" past the blade. Use this setup to cut 16 or more 1/8" wide flat pieces from the 2 1/4" by 5" block. Watch your fingers, and don't try to cut more slices after the block gets less than 1" wide. Be careful that the slices don't fall through the gap in the saw table – if this is a possibility on your saw, you'll need to codge up a temporary table insert from plywood or particle board that you can use to make sure the pieces don't fall through.

2. **Bowl Wedges** — Adjust the saw blade to a 22 1/2 degree angle and raise it to about 2 1/2” out of the table (perpendicular to the table, not along the blade). Cut wedges from a piece of scrap to make sure that the angle is correct. In this case, you’re preparing to cut pieces for 8-sided rings, so you can test the saw’s adjustment by cutting two wedges and making sure that you can put them against a try- or framing square and have them touch each other and both inside edges of the square. When you get to this point, try cutting 4 wedges from scrap and ensuring that you can put them together against a straight edge (or your rip fence) and have no gaps. Also, when you get to this point, the length along the straight edge should be twice the distance from the straight edge to the outside of the middle joint. When the saw is adjusted, clamp a scrap block to the auxiliary fence so that you are cutting pieces 3 25/32” long on the “long side”. Now cut 8 wedges (plus maybe one or two spares) from the 2 3/16” wide stick of the bowl species and the same number from the 1 5/16” wide stick of the bowl species. Note that the minimum lengths specified above allows for a couple of inches of extra for your fingers’ sake, but no full spare wedges.

3. **Brick Wedges** — Adjust the saw blade to an 11.25 degree angle. Again, cut wedges from a piece of scrap to ensure accuracy of the setting. You can check the angle as before, except that you need 4 pieces to check the angle on a square (1/4 ring), and 8 to check it along a straight edge (1/2 ring). Clamp a scrap block to the auxiliary fence so that you cut wedges that are 1 11/16” on the long side. Cut 16 wedges from the stick of brick species (plus maybe one or two spares).

4. **Mortar Wedges** — Leave the blade at the 11.25 degree setting, but move the scrap block on the auxiliary fence so that you are cutting wedges 1 13/16” long. Cut 16 wedges from the stick of mortar species (plus optional spares).

4. Semiring taping:

1. Using 3/4”-wide duct tape (cut as described earlier), tape up 4 4-piece semirings, two from the narrow bowl-species wedges, and two from the wider ones. It is more important for these rings that the joints be tight than that the semirings be precise half-rings. To help ensure this, as you tape down each piece of a semiring (after the first), place one corner of the new piece about 1/8” to 1/4” up the edge of the previous piece, place the new piece’s far end on the tape, then press down on the new piece until it is secure against the tape. Bring the tape across the open end of the semiring, and leave a couple of inches extra at the end.

2. Using 3/4” wide duct tape, tape up 2 8-piece semirings from the mortar wedges. Use the technique described in the previous step to help to ensure tight joints.

3. Using full-width (2”) duct tape, tape up 2 15-piece semirings from the brick wedges and most of the mortar slices. Start each semiring with a brick wedge, and alternate between the brick wedges and the mortar slices until you have 8 brick wedges and 7 mortar slices. Use the technique described in a previous step to help to ensure tight joints — note that this doesn’t work quite the same with the mortar slices.

5. Semiring gluing: Using yellow wood glue, glue all of the joints in each of the 8 semirings. I prefer to put glue on both surfaces of each joint, because it makes for more reliable joints (if not necessarily any stronger). For each semiring, after you have applied glue to all of the joints, pull the tape across the open end and tape it down so that the corner-to-corner distance across the open end is as close as you can manage to twice the distance from the line across the open end to the opposite corner – measure this either by measuring across two semirings placed together, or by standing the semiring on its open end and measuring its height using a square. After the tape is in place, use your fingers to make sure that all of the joints are even – that the top and bottom faces of each wedge are as close as manageable to flush with the top and bottom faces of adjacent wedges and that the outer edges of adjacent wedges meet at the tape (rather than having one not quite touching the tape at its corner and therefore not meeting its neighbor evenly). Note that for the 8-sided (4-sided, really) semirings, it's more important for the joints to be tight than for the semirings to be precisely 180 degrees of a circle. For the 16-sided and 32-sided semirings, it's more important for the semirings to be as close as manageable to perfect half-circles — the limited profile means that any oblong-ness in these rings will reduce their outside diameters and increate their inside diameters, possibly by a significant portion of the intended profile. On the 32-sided rings, ensure that the slices meet outside corners of wedges at all four corners, except that it's ok if the slices stick out a little bit above or below the wedges, as long as they're vertical.

When gluing the semirings, do matching semirings one after the other. When the second one of a set is done, ensure that the distance across its open end is about the same as for its partner. Depending on how fast you work, you may have to settle for adjusting the second semiring, since the glue on the first one may already be too set to permit adjustment. Put the two matching semirings together (open ends facing), and put several rubber bands around the two. I like to use three or four light-duty rubber bands on a 3/4" high ring, and 6 or 7 on a wider ring. For the 32-sided semirings, it may be easier to get the joints to stay tight if you place a mortar slice (or same-width scrap) between the open end of the semirings. Set the semirings aside to set.

5. Semiring Dressing: After the glue has set, remove the rubber bands and the duct tape. At this point, you have to ensure that the open ends of the semirings can be made to mate. This can be done by several methods, but I prefer using a disk sander that is at least 1" larger in diameter than the finished rings — this is important because I've found that sanding disks tend not to be adequately flat for the last 3/8" or so at their outside edges. So, for bowls up to 11", you can use a 12" sanding disk. For this bowl, a 10" sander is probably adequate. To use a disk sander to dress a semiring, place the semiring on the sander's table and gently push it against the sanding disk, taking care to present the semiring with the open end parallel to the disk, and to take it away similarly, so that the ends don't get sanded unevenly.

An alternate method is to clamp a length of cloth sandpaper across a known flat surface (a table saw table works well), adjacent to a perpendicular surface (such as the table saw's rip fence). Use a pencil to cover the open ends of each semiring with a marking. Take each semiring, and run it back and forth along the sandpaper, keeping it pressed up against the perpendicular surface, so that the sanded surfaces are perpendicular to the faces of the semirings.

With either method, if the surfaces (table-and-disk or table-and-fence) are not exactly perpendicular, this can be compensated for. Mark one face of each semiring, and sand one of each pair with the marked face up (toward the fence), and the other one down (away from the fence). In this way, you get any non-perpendicularity to cancel out.

6. Ring Glueing: for the 8-sided and 16-sided rings, this is simply a matter of applying glue to the open surfaces, putting the mated semirings together and applying rubber bands to hold the semirings together while the glue sets. For the 32-sided ring, it is also necessary to glue in a mortar slice on each side.

7. Ring Facing ("One-Side Facing"): It's now necessary to get one side of each ring clean, flat, true, and mostly round. For this step, I ordinarily use a 4-jaw chuck with rubber-buttoned "bowl jaws", but in lieu of this, one can also use a piece of particle board or plywood on a faceplate and double-sticky tape. In fact, for some bowl designs, it will be noticeable if the detail ring is be wobbly (skewed) relative to the bowl's vertical axis. In these cases, the plywood and double-sticky tape is preferable.

For the plywood method, attach to a faceplate a piece of plywood that can be rounded to a slightly larger diameter than the outer diameter of the ring (larger than the actual O.D., or "flat" diameter is adequate). Round the plywood, and true the outer few inches as well as possible using a square-end scraper. When using the square-ended scraper for this purpose, I try to make sure that most of the pressure on the tool is directed down toward the tool rest, rather than in toward the disk. Use a scraper or gouge to lower the surface of the plywood near the center of the disk. Finish truing the outer part of the disk using a sanding block (with 80- or 100-grit cloth-backed sandpaper): mark the surface of the plywood with a pencil, then rub the sanding block back and forth on the surface, along the tool rest, until the pencil marks are completely gone and the surface feels smooth. When pressing the sanding block against the disk, apply pressure slightly downward, so that it stays against the tool rest, and only near the center of the disk. When you are done, the disk should feel true to the fingernail — a fingernail placed lightly against the rotating face shouldn't feel any wobble.

To attach a ring to the disk, mark its "corner" diameter on the disk and place the ring against the disk. Find four roughly equally-spaced places on the ring that are in good contact with the disk, and mark these. Attach pieces of two-sided tape to these four points, then press the ring against the disk. I prefer to use C-clamps to ensure that the ring is well attached to the disk. Now, use the square-ended scraper to cut off most of the corners from the ring, to about half its thickness on the outside, and to cut off most of the flats on the inside of the ring. Next, use the scraper to true up the ring as well as possible, then use the sanding block to finish the job. Note that this is the same thing you did in preparing the disk for holding the rings. Get good at this step. You're going to be doing a lot of it.

True up one face of each of the four rings. One thing to be careful of is to make sure that the brick wedges and mortar slices are all flush when you've finished truing up the 32-sided ring. For this ring, you may have to use a file or something to make sure that you have adequate contact between the ring and the holding disk — having a ring come off the disk while you're truing it won't break the ring if it's glued together properly, but it's awfully irritating, and also rather startling. But if you had bits of mortar slice sticking out of one side, then you probably have divots on the other side where they don't come up quite flush with the wedges around them. Make sure that you've removed enough material from the smooth face that there aren't any divots left.

Base Attach: After you've put a good side on each of the rings, attach a square of scrap wood to a metal faceplate. I use 3/4" particle board for this, usually. Particle board is fine for bowls, but I've had multiple failures using it with more vase-shaped forms, because the area of the glue joint to the base of the bowl isn't great enough. Round and true the scrap disk with the scraper and sanding block, as before. I like to gouge out the inner 3-4" of the scrap disk and only glue the outer 1" to 1 1/2" to the base of the bowl. After truing the scrap disk, measure its diameter and use a compass to transfer this measurement to the square that will be the base of the bowl. Apply a ring of glue to the base square, attach the scrap disk centered on the marked circle, and clamp.

Lower Bowl Ring: When the glue has set, return the faceplate to the lathe and round the base ring using scraper and/or gouge (I like to get close with the scraper, then use the bowl gouge to avoid creating tearout). Use a gouge to "hollow out" that part of the base which is inside the inner diameter of the wide bowl ring – the part where the ring won't contact the base. Use scraper and sanding block to true the surface. Measure the diameter of the base and the O.D. of the ring on its "good side". Set a vernier, straight, or outside caliper for half the difference, and use this to center the base on the good side of the ring. When you can place the caliper at any point on the ring's outer edge and have it just touch the base, you are exactly centered. When this is the case, use a pencil to draw a line around the base, remove it and apply a ring of glue inside the line. Put the base back down on the ring, move it around until the glue is evenly spread, then make sure it is centered on the pencil line, and clamp. Allow the glue to set.

Lower Mortar Ring: When the glue has set, round and true the top of the lower bowl ring and attach the 16-sided "mortar" ring to the lower bowl ring as above. Allow the glue to set.

Lower Mortar Ring Dimension and Brick Ring Attach: True the upper surface of the mortar ring as before, and round off inside and outside corners. In this instance, it pays to leave a little bit of flat on the outside and a little bit of corner on the inside. Particularly, if the mortar ring crept out of true when you clamped it down, leave flats on at least some sides, to avoid unnecessarily reducing the diameter of the mortar ring for later operations. Now, mark the mortar ring about at a point about 1/8" plus about an extra 3/128" above where it attaches to the lower bowl ring. Use a parting tool to cut off everything above that point. It is usually necessary to lose about 1 1/2 times the width of the parting tool in "kerf" for this operation, since it's seldom possible just to push through in one operation with the parting tool. Make sure that the parting tool stays as close as possible to perpendicular to the axis of rotation for this, to avoid losing more wood than necessary. When the cut is nearly complete, place a gloved hand inside the ring to catch it when it is parted loose. It's not necessary or desireable to get a firm hold on the ring when it comes loose; rather, you just want to have your hand inside the ring, so that it doesn't go anywhere while it spins down. I don't advise doing this without a glove.

After the remainder of the mortar ring has been parted off, set it aside and true up the part of the mortar ring that remains on the bowl. Make sure not to remove too much material in the process. I like to get this to within 1/128" of 1/8". This much precision may not be necessary, since the rings will appear somewhat different in thickness eventually, due to the curvature of the bowl. That said, however, it's preferable to err on the side of "too thick". When the lower mortar ring is true and approximately the right thickness, glue the brick ring's good side to the lower mortar ring as before.

Lower Brick Ring Dimension and Middle Mortar Line Attach: When the glue sets from the last operation, return the blank to the lathe, true up the top edge of the brick ring, and remove its outside corners and inside flats. Be careful on the inside, since there are probably bits of mortar slice sticking into the middle, and you don't want to either hurt yourself on them or rip huge chunks of them out (a concern, since their grain runs vertically). Careful use of a square-ended scraper is usually adequate to do this safely, but gung-ho-ness is not recommended at this stage. Mark a line approximately 15/16" to 1" above the bottom of the brick ring and part above that line, as before. True and clean the upper surface of the part of the brick ring which is still attached to the blank. Glue the good face of the loose mortar ring to the just-cleaned brick ring surface.

Middle Mortar Ring Dimension and Upper Brick Ring Attach: As before, true up the exposed face of the mortar ring, mark it about 1/8" plus 3/128" above its lower edge, part above that point, and clean and true to about 1/8”. Glue the good surface of the remaining half of the brick ring to the clean and true mortar ring surface.

Upper Brick Ring Dimension and Upper Mortar Line Attach: As you did two steps ago, mark off about 1” of the brick ring. This time there shouldn’t be enough extra to be worth anything, so just scrape or gouge off anything above the 1” mark, then true and clean the upper surface. Glue the good face of what’s left of the mortar ring to the cleaned surface.

Upper Mortar Ring Dimension and Upper Bowl Ring Attach: If there’s enough left to the mortar ring over the required 1/8” to be worth saving, clean, true, and part as before; if there’s less than an extra 5/16” (7/16” overall), just use a scraper or gouge to eliminate anything over the 1/8” mark, then true the exposed surface. Glue the good side of the upper bowl ring to the cleaned surface.

OK. After the glue from that last step is set, the blank is complete. You’re now ready to turn it to its final shape.

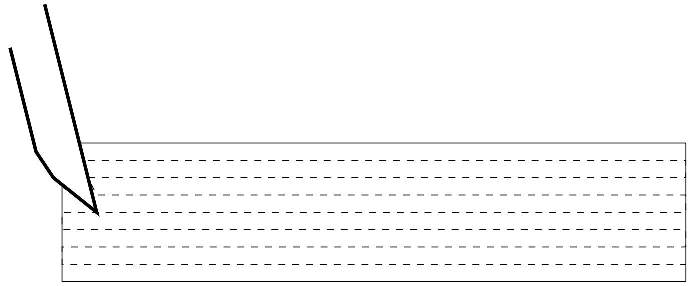
3 Turning the Segmented Bowl

To turn a bowl like the brick bowl, you’ll need, at the very least, a bowl gouge and a parting tool. A large round-nose scraper will also come in handy, and you’ll need a variety of grits of sandpaper, starting from around 80-grit and working up through 320 or so. Cloth-backed sandpaper is almost infinitely superior to paper-backed for this purpose, as it lasts a lot longer, and holds on to its grit better.

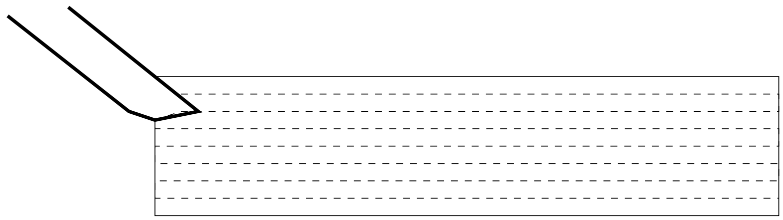
The bowl will be turned in two stages. First, we’ll turn the “front”: the outside of the bowl, except for the bottom inch or so, will be turned to its final shape, finish-turned, and sanded. The bottom inch or so of the outside will be roughed out. The inside of the bowl will be turned to its final shape, finished turned, and sanded. After all of this is done, we part off the bowl from its scrap base, turn it around, and finish off the bottom of the outside and the base of the bowl.

The outside of the bowl is best turned with a fairly steeply ground bowl gouge. Because the grain is running “around” the bowl, it’s not critical whether you turn from larger-to-smaller or smaller-to-larger, except for the bottom layer. The main thing to be careful of is that you don’t remove too much material. For the most part, I like to start by getting rid of most of the discontinuities caused by the segmented buildup, then begin putting the final shape on the outside as I’m approaching a smooth shape. In this way, I am able to avoid removing lots of extra material.

For the bottom layer, it is important that the final stages of the outside be turned from smaller-to-larger, because the bottom layer is mounted “plank-grain”. However, this is difficult to do while the bowl is mounted to the faceplate, because the headstock and the faceplate and scrap get in the way. To get close to the final shape, then, we use a steeply ground bowl gouge and some care. With the bowl gouge turned up on its side (with the flute facing out), it is possible to get a fairly clean cut on plank-grain wood as long as the point of the flute is the “lowest” point on the gouge. As figure 2 shows, if the point is cutting the fibers of the wood, as in part (a), leaving the side of the gouge flute to peel off the unwanted ends of the fibers, then a fairly clean cut can result. If, though, as in part (b), the side of the flute is scraping away the ends of uncut fibers before the point severs those fibers cleanly, then extreme tearout can result. That said, we don’t want to even *try* to put the finished surface on the base from the front. We just want to get close, so that we won’t have to do heavy turning after we turn the bowl around.



(a)



(b)

Figure 2: Cutting from larger-to-smaller on plank-grain wood: (a) if the sharp point of the bowl gouge is the first thing across any given fiber of the wood, then tearout will be relatively small. (b) If the side of the flute is scraping fibers before they've been severed from the "good part" of the bowl, then heavy tearout can result.

When you get done putting the shape on the outside with the bowl gouge, there will likely be some (hopefully minor) chipout, and perhaps some chatter on the outer surface of the bowl. Much of this can be gotten rid of using a square- or skew-ended scraper. You'll want a good sharp edge on the scraper, and as during the blank buildup process, you'll want to hold the scraper so that your primary pressure is down against the toolrest. Advance the scraper very gently, so that you clean up the chatter and roughness in very small increments. By holding the scraper down, rather than forward, you'll ensure that you aren't creating new chatter or roughness as you go. When you've gone as far as you can with the scraper, switch over to the sandpaper. Use the lowest grit sandpaper until the only flaws in the surface finish are those caused by the sandpaper. Then switch to the next higher grit, use it until the lowest-grit flaws are gone, then switch to the third grid, using it to eradicate signs of the second grit, and so on, until you're happy with the finish. I usually go to 320 grit, then switch to 4-ought steel wool.

The inside is somewhat harder to turn than the outside. For one thing, there is the need to make sure you don't make the bowl too thin at any point. I check my thickness frequently as I'm turning the inside. For this, I usually use an outside caliper set to a known amount – 1" works really well. I put one end of the caliper inside the bowl, usually against a horizontal joint. On the outside, I line the other end up with the joint, or whatever I'm using as a measuring reference, and place a ruler against the bowl, and note the distance from the other end of the caliper to the 1" mark (or whatever the caliper is set to). That distance is the thickness of the bowl (*not* the distance from the bowl to the end of the caliper!). For smaller bowls, I go with about 1/4" as a desired finished thickness.

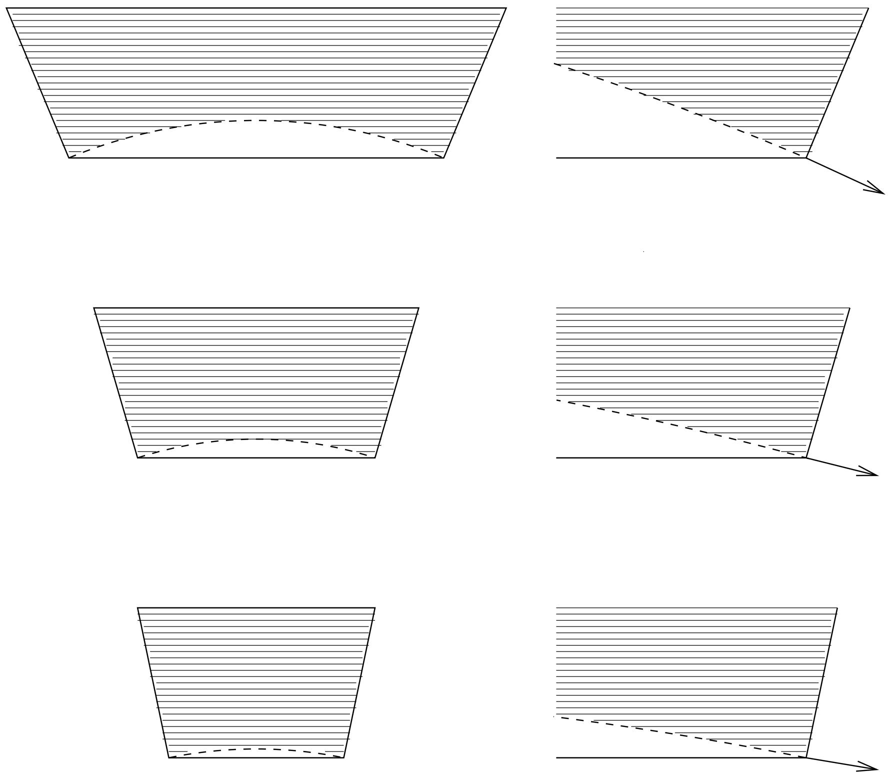


Figure 3: When turning the inside of a segmented bowl, one often encounters chipout at the trailing edges of the segments. This figure shows part of the reason for that. After the segmented ring has been rounded out on the inside, the inside corners of the segments have short pieces of relatively unsupported grain. As the closeups on the right show, the cutting action as the trailing edges of the segments pass the tool is in a direction which will attempt to lift this grain, sometimes pulling noticeable chunks loose. Solutions to this: (i) use more segments. The three rows of this figure show the situation for 8-, 12-, and 16-sided rings. As can be seen on the right, the angle between the tool and the grain is much closer to parallel with the larger number of segments. (ii) Use a steeply ground gouge, and attempt to get as close as possible to the desired shape using large cuts. The idea is to use the sharp point of the gouge to cut the fibers while there is still surrounding wood to provide support.

For larger bowls, I aim more for 5/16” to 3/8”. Near the bottom, it is necessary to measure the minimum thickness, rather than just the thickness parallel to the bowl’s base – otherwise, you can easily end up seeing more daylight through the lower part of the bowl than you might wish.

Another difficulty with segmented buildups is that they are prone to a fair measure of chipout on the inside, particularly if, as in the brick bowl, the grains don’t all run tangential to the axis of rotation. Figure 3 shows why: you’re lifting slightly up on short, minimally supported bits of grain. To minimize the chipout, I recommend using a sharp gouge and taking slow, thick cuts (though, as the figure shows, using more segments makes the lifting less pronounced). Once I have eliminated most of the discontinuities from the blank on the inside, I might put much of the final shape on it with 6 to 10 passes of the gouge. Each pass, though, might remove between 1/16” and 1/8”, and take a couple of minutes to complete. Start by turning down to just above the point where the bowl needs to start seriously narrowing. Below that point, you don't want to use a steeply ground bowl gouge for anything but a bit of roughing, or you'll turn the bottom out, as sure as shooting. Below that point, I usually use a very bluntly ground bowl gouge, though a fairly wide, flat round-nose scraper will also suffice. For the brick bowl, this will be for part of the lowest ring and the base. I like to leave the very center of the bottom intact as long as possible. This helps to gauge how much material has been removed. Often, this center bit is best removed with a round- or square-nose scraper. These scrapers are also useful for removing some of the roughness and chipout that will likely be present on the upper part of the bowl's inside after one finishes with the gouge, but use a very light touch and a very sharp scraper.

The inside will likely need a fair amount more sanding than the outside, at least if there's much chipout that you can't get rid of with the scraper. Two places will need particular attention: The detail ring will likely have most of the chipout. The other place that will need attention is the spot where you stop using the steep gouge and start using a blunt gouge or scraper. That spot is pretty hard to get completely smooth with the tools. Again, do most of the work with the coarsest sandpaper, then work up to the finest and steel wool.

Once you have the inside and the upper part of the outside in finished form, it's time to part the bowl off of the scrap and turn it around. Use the parting tool to do this, keeping a gloved hand on the bowl to grab it if you overdo it and part the bowl completely while it's turning. I prefer to get a 3/4" or so groove, then use a chisel and mallet to finish the parting job. Here's a place where using particle board for the scrap is a useful thing: If you have to use force to get the two apart, the particle board is much more likely to give out than the base of the bowl.

To turn the bottom of the bowl, you will need to attach it to the lathe mouth-first. There are a number of ways to do this. The "bowl jaws" available for most of the 4-jaw chucks on the market will do a good job of this, though you'll have to decide whether to hold the mouth of the bowl from the inside or the outside based on the shape of the bowl. You can also use a "ring chuck", which is a faceplate with a disk of plywood on it that is at least 3-4" larger in diameter than the bowl, and a ring of plywood with a hole in it that is smaller than the bowl, but which has the same diameter as the solid disk. Matching holes are drilled in the disk and the ring to allow for bolts to go through, that are used to hold the ring down on the bowl and the bowl down on the disk. Finally, and perhaps most simply of all, you can use a disk of plywood or particle board with a groove in it that fits the mouth of the bowl, a little bit of double-sticky tape, a live center, and a small disk of scrap wood which goes between the base of the bowl and the tailstock. The idea of this last is that you turn all but the center couple of inches with the tailstock in place, then use the double-sticky tape to hold the bowl while you carefully turn the center of the base. Just be sure that there's no extra dust on the bowl or the plywood/particle board disk, so that you can get a reliable hold from the tape.

For the actual base turning, there are three parts. First, you need to finish turning the bottom of the bowl's outside. This is best accomplished with the steep bowl gouge and possibly a flat scraper, working from smaller-to-larger. Since there will usually be at least a little bit of difference in the mounting of the bowl from the original to the inverted, it's best to use sanding to smooth over any oddities that arise from the centers of rotation not being identical. Second, you need to hollow out the center of the base a little bit. To get the bowl to sit on a flat surface reliably, it's best just to have a narrow (less than 1/2" wide) ring sitting on the table, rather than a whole disk. The hollowing doesn't have to be deep, and can be done with either gouge or scraper. Sanding here doesn't *have* to be as assiduous as on the upper parts of the bowl, but shouldn't be passed over too much, partially just as a matter of pride — particularly if you're in the habit of signing or pricing your pieces on the bottom. Take it from me, if nothing else, other *turners* will notice if you leave the bottom *too* sloppy. Finally, the sitting surface itself needs to be made nice and flat. Use a scraper to get close, as during the buildup process, then use the sanding block to get a true, flat, relatively smooth surface. Here is a place where it pays to skip grits on the sandpaper: you want to use a coarse grit on the sanding block, then skip to a fairly fine grit handheld piece of sandpaper to do a little bit of surface smoothing without losing the flatness of your surface. If you're using the tailstock to help hold the bowl in place, the sitting surface and the area inside of the sitting surface will have to be sanded after the tailstock is removed. Once the bottom is sanded, you're ready for finishing.

It's possible to put a finish (lacquer or oil) on the bowl while it's on the lathe, but I prefer not to. My preferred method is to use two coats of a tung oil sealer followed by two coats of an actual FDA-approved food-safe finish. The latter is less necessary if you're not going to sell the bowls, but I don't want to have to waffle on the matter of food-safeness when someone asks me. I use a small amount of tack cloth to get all of the extra sanding dust off of the bowl before I apply any finish. Pay particular attention to any dust that might be hiding in any chipouts – the chipouts are much more noticeable if there's contrasting dust sitting in them, contaminating the finish. For each coat, I apply the finish with a rag or high-grade paper towel, let the bowl sit for a day or two, then go over it with four-ought steel wool. Oh, and if you're going to sign and date the bowl, do it before you put any finish on – it works a *lot* better if the ink can actually sink into the wood a little bit, rather than just sitting on top of the finish.

Anyways, you are now the proud owner of a segmented bowl that you yourself have made. More importantly, you now know how to do it again, and probably a *lot* better the next time.

4 Determining Segment Size and Shape

The length, width, and angles of segmented ring's segments is determined by the maximum desired outside diameter, the minimum desired inside diameter, and the number of segments. Figure 1 shows an example of a segmented bowl. The boldest lines suggest a contour for the bowl's final shape. The thinner, solid lines suggest inner and outer diameters for each ring of the bowl blank, and the medium dashed lines show the inner "flat" diameter corresponding to the actual inner diameters for each ring.

On the subject of "margin for error", and this is mostly personal opinion: For early attempts at segmented bowls, an extra 1/8" to 1/4" on both the inside and the outside is probably a good idea. For later efforts, less margin for error is acceptable, but may be desirable for later "creative freedom". In the figure, at least 3/16" of slop has been allowed relative to the suggested shape in most places. The detail ring is an exception in this case, but a bit of extra has been left on the inside. The exception is for two reasons: Since the glued-up ring for the bricks needs to be 2 1/4" high, it's only feasible to make it with the stock up on edge, rather than lying flat, which reduces the amount of choice we have in how much profile we can have. Secondly, since the brick ring has 32 pieces, it's much easier to guarantee that it will be very close to round when finished: there are enough joints in the ring that we can cover up a few degrees of aggregate error during the gluing process. This means that we don't need as much extra material to cover for eccentricity of the ring.

All of that said, we'll now discuss two ways of determining the length, width, and angle of segments for a standard segmented ring. The first method uses a little bit of trigonometry. If trig doesn't bother you, it's pretty easy to remember these formulae after a few goes at making segmented bowls. The second method uses a table and minimal arithmetic, but requires keeping track of the table. For these methods, n is the number of identical sides, OD is the ring's maximum outer diameter, ID is the ring's minimum inner diameter, θ is the **half-angle** — the mitre angle at each end of the segment, where 0 degrees is a normal right-angle cut, LS is the length of the long side of the segment, w is the width of the stock from which the segments are cut, and $stick$ is the length of the piece of stock needed to get the n segments required for the ring. In determining the value of $stick$, we assume a saw kerf of 1/8", and that we want an extra 1 1/2" or so of wood to hold onto while cutting the last piece.

Method one (with trigonometry): If the equations make sense, there's not much else to say about them.

$$\theta = \frac{360}{2n} \tag{1}$$

$$LS = OD \tan(\theta) \tag{2}$$

$$w = \frac{OD - ID\cos(\theta)}{2} \tag{3}$$

$$stick = n((OD - w)\tan\theta + \frac{1}{8}'') + w\tan\theta + 1\frac{1}{2}'' \tag{4}$$

Method two (no trigonometry):

The no-trigonometry method uses lookup tables and a little bit of arithmetic to determine segment measurements. Table 1 shows the mitre angle for 8-, 12-, and 16-sided rings. In Table 2, the lefthand column under each number of sides shows the value of LS, the long-side length of each wedge. The righthand column under each number of sides shows the inner "flat" diameter that corresponds with a given actual inner diameter. As can be seen from figure 4, the maximum inner diameter of a segmented ring is the distance between opposite corners. The inner "flat" diameter is the distance between the middles of two opposite segments. To get the stock width, w, for a given outer diameter and inner diameter, look in the right-hand column for the appropriate number of sides. Get the number ID_{flat} which corresponds to the desired actual inner diameter. Then the stock width is determined by the following:

$$w = \frac{OD - ID_{flat}}{2} \tag{5}$$

The stick length, $stick$ is harder to determine with this method. I recommend the following formula:

$$stick = n \cdot (LS + \frac{1}{8}'') \tag{6}$$

This formula is slightly more wasteful of wood than the one used in method 1, but is the easiest to deal with, math-wise.

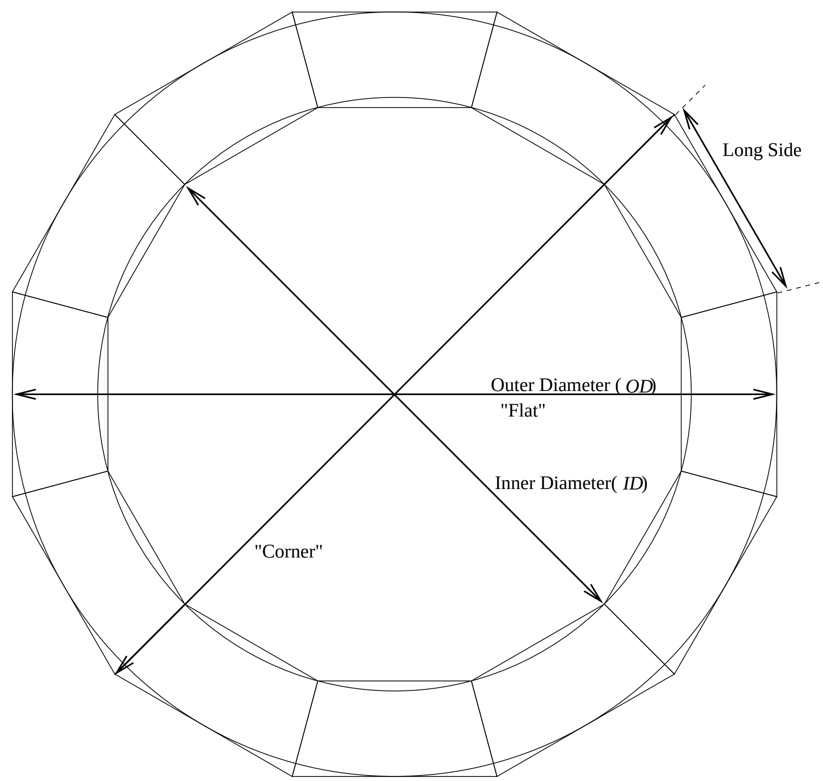


Figure 4: A 12-sided segmented polygon/ring before rounding. Note that the maximum outer diameter that can come from this is the distance from the middle of one segment's outside edge to the middle of the opposite edge, but that the minimum inner diameter is the distance from the inside corner on one joint to the inside corner of an opposite joint. The width of the stock used to cut the segments, though, requires the inner "flat" diameter, which is the distance from the middle of one inside edge to the middle of an opposite edge. ID and ID_{flat} are related by a cosine factor, but that's another story.

Table 1: Mitre angle for 8-, 12-, and 16-sided rings

Number of Sides	Mitre Angle
8	22 $1/2°$
12	15°
16	11 $1/4°$

5 Get To It!

Enough with the talking, already. This article isn't intended to turn you into Ray Allen or Bud Latven, but it should be enough to get you started on segmented turning. There's a whole world of other stuff beyond what's here, but you'll have to discover much of that for yourself. Perhaps the

Table 2: This table shows, for 8-,12-, and 16-sided rings, the long-side length, LS, and inner "flat" diameter for diameters from 5" to 12".

Diameter	8 Sides		12 Sides		16 Sides	
	LS	"Flat" Diameter	LS	"Flat" Diameter	LS	"Flat" Diameter
5	2.07	4.62	1.34	4.83	0.99	4.90
5 1/4	2.17	4.85	1.41	5.07	1.04	5.15
5 1/2	2.28	5.08	1.47	5.31	1.09	5.39
5 3/4	2.38	5.31	1.54	5.55	1.14	5.64
6	2.49	5.54	1.61	5.80	1.19	5.88
6 1/4	2.59	5.77	1.67	6.04	1.24	6.13
6 1/2	2.69	6.01	1.74	6.28	1.29	6.38
6 3/4	2.80	6.24	1.81	6.52	1.34	6.62
7	2.90	6.47	1.88	6.76	1.39	6.87
7 1/4	3.00	6.70	1.94	7.00	1.44	7.11
7 1/2	3.11	6.93	2.01	7.24	1.49	7.36
7 3/4	3.21	7.16	2.08	7.49	1.54	7.60
8	3.31	7.39	2.14	7.73	1.59	7.85
8 1/4	3.42	7.62	2.21	7.97	1.64	8.09
8 1/2	3.52	7.85	2.28	8.21	1.69	8.34
8 3/4	3.62	8.08	2.34	8.45	1.74	8.58
9	3.73	8.31	2.41	8.69	1.79	8.83
9 1/4	3.83	8.55	2.48	8.93	1.84	9.07
9 1/2	3.94	8.78	2.55	9.18	1.89	9.32
9 3/4	4.04	9.01	2.61	9.42	1.94	9.56
10	4.14	9.24	2.68	9.66	1.99	9.81
10 1/4	4.25	9.47	2.75	9.90	2.04	10.05
10 1/2	4.35	9.70	2.81	10.14	2.09	10.30
10 3/4	4.45	9.93	2.88	10.38	2.14	10.54
11	4.56	10.16	2.95	10.63	2.19	10.79
11 1/4	4.66	10.39	3.01	10.87	2.24	11.03
11 1/2	4.76	10.62	3.08	11.11	2.29	11.28
11 3/4	4.87	10.86	3.15	11.35	2.34	11.52
12	4.97	11.09	3.22	11.59	2.39	11.77

main possibility that this article has avoided is the more complicated detail layer. The pieces used in the brick bowl's detail ring are all simple segments and flat pieces. By making more intricate shapes and glueups, then cutting those into wedge shapes and gluing them together into one or more rings, it is possible to get an almost unlimited variety of interesting patterns. But it would be difficult to describe even a small fraction of the possibilities. Start with simpler designs, like the brick bowl. Once you get comfortable with designs like that, start letting your imagination have free reign. And never be afraid to attempt a bowl design. If you get into something and discover a problem with it, or happen to do something terrible to the blank once you’ve gotten it ready for turning, well, think about what went wrong, rest up a little bit, then dive back in!