Piedmont Triad Woodturners Association

Profile Turning

June 12, 2012

Jim Barbour

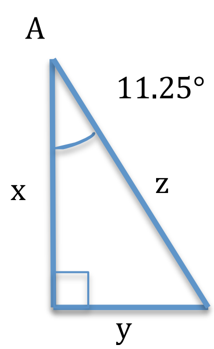
The objective here is to make a large number of flat objects, all identical. The finished product is very similar to what you might produce on a scroll saw by stacking several sheets of thin stock and cutting out many identical pieces. We, however, are putting together a round piece of stock and turning the items all together so that they are truly identical, and then cutting them free for make the individual pieces. This is a form of segmented turning, but does not require the precision normally associated with segmented turning as we will eventually be cutting the finished piece into slices along our glue lines. The reason we don't simply start with a round blank is that we want the grain to run as nearly as possible with the long dimension of our object rather than through it from side to side. Remember that it will end up only a quarter inch or less thick and may have some pretty thin segments from side to side. Thus the section that would end up effectively quarter sawn will be quite fragile. There are basically four steps:

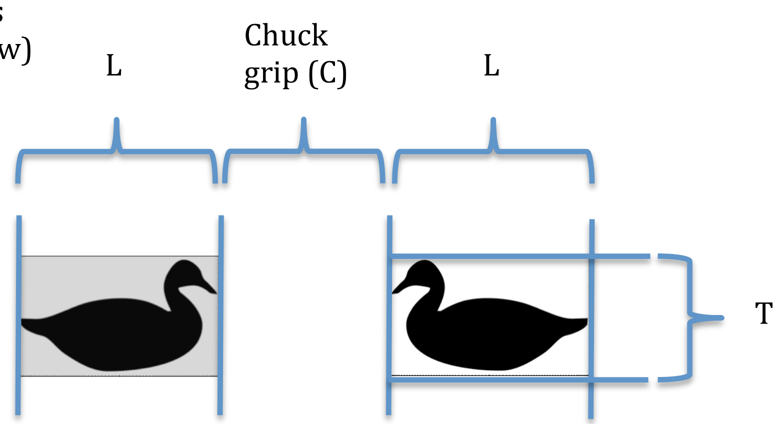
- deciding what you want to produce and sawing out a sample to be used as a template
- creating a blank from which we will be turning the object, which involves two steps
    a. cutting the segments we are assembling to form the blank
    b. gluing and flattening the blank
- turning the object itself
- slicing the turning into the flat final pieces

Creating the template for your turning
Create your template for the turning by drawing what you want to create and cutting it out from a piece of thin (1/4" or less) stock; plywood is fine, any thin leftovers will work, even cardboard or plastic will work. Use whatever you have to hand and either paint it a color contrasting with the wood you are using for the final product, or use something that naturally contrasts. You just need to be sure it will hold up to glue, can be easily distinguished from the turning stock, and will not damage your tools when they cut into it a bit (steel is out!) Since most of my turnings tend to come from lighter colored wood, I simply use some Masonite I have left over from another project.

Sizing your object and determining board dimensions

1. Decide what you are going to make, create the template and measure its length (L) and height (T (for "thickness))
2. Determine your chuck gripping diameter (C)
3. Your triangles will need to be L + (½)C (call this "x") from base to tip
   Each half of the triangle has a
    a. top angle of 11.25° and
    b. height of x (L + C/2) inches
    c. width of y inches (see below)





4. To calculate our original board size note that we need eight pieces, each x long by 2y wide. The dimensions we need are the length (8x), width (2y), and thickness (T) of the board plus allowance for kerf.

There are a couple of ways of determining the size board we will need to make up our segmented blank. One is to do the math and measure carefully. The other is to first take our template to a likely board, hold it against the edge to make sure the board is at least as thick as our template is high, add a couple of inches to our template's length and be sure our board is eight times that long. Then we are concerned with width. The basic shape we are creating from our board is an isosceles triangle with a top angle of 22.5°. In this special case the base of the triangle (width of our board) will be roughly 40% of the height of the triangle (length of the template plus a couple of inches). So, if our template is an inch high and the length plus a couple of inches is 5", the board needs to be at least 40" long, 2" wide and 1" thick. It is really not critical for most cases since we can simply adjust the size of the template a bit to accommodate whatever stock comes most easily to hand.

If, on the other hand, we are constrained to an exact final object size, and are working with expensive wood, finding the exact dimensions becomes important. In that case the section below may be helpful. This can be adjusted to make blanks of different numbers of segments and for any size final object, but is perhaps best illustrated via an example.

5. Let's calculate the width using an example of a duck 3" by 1" (L=3, T=1) held in a 3" chuck.
   a. Going back to trig in high school, we know that tanA° = y/x. (SEE, your math teacher *told* you this would come in handy some day!)
   b. We already know x, it is L + C/2, so for a three inch long object, 1 inch tall, and a 3" gripping space for our chuck, x = 3 + 1.5 = 4.5"
   c. Looking up tan11.25° we find 0.1989
   d. So, 0.1989 = y/4.5 or y = 0.8951.
   e. Thus our pieces need to be 4.5" X 1.7902", call it 4 1/2 x 1 25/32.
   f. For the length we need eight pieces, each 4.5" plus 1" for kerf. 4.5X8 + 1 = 37.
   g. We can get this from a board 2 x 37 x 1.

While the precision above may be important in some cases, I have found that while it *can* be cut from this board I am better served to allow a bit more in length for safety reasons. When you come to the final cut if you do not have some extra stock it becomes difficult to hold the piece safely on a table or chop saw. If I were cutting on a band saw or by hand, the extra length would not be as important.

Creating the blank

There are lots of ways to make triangles; band saw, table saw, chop-saw, etc. I use a combination of table saw and chop saw. Here's how I do it.

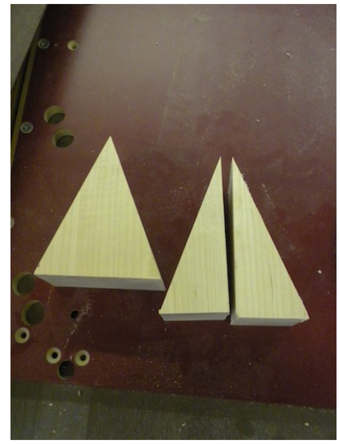
1. With your original stock, clean up both edges and both faces
2. Rip to width and cut to length (this is easier if you allow 6" or so extra length, but can be done to exact measurements)

3. On the table saw set a miter-fence to 11.25° (A cut-off sled is best, but a miter-gauge with a top hold-down will work fine.)
4. Find and mark the center of the width of your work piece – the center that would rip the piece into two full-length, half width pieces it. This center is the long point of our triangles. (We are not going to rip it, so don't go back and add in the kerf in the width above!)
5. Set the miter-gauge to cut through this center point, just leaving the mark.
6. Cut the first long side of the first triangle.
7. Flip the board over, and using the beginning point of your cut (along the length of the board), mark the miter-gauge at this point. This is your cut-mark.



8. Clamp the board and cut the other long side of the first triangle.
9. Take the board to a chop saw and cut the base of the triangle, freeing it from the board.
10. Now, using the first triangle as a guide, mark the board up its length, leaving enough to allow for the kerf. This is not critical, but it will affect the amount of lumber you need to complete the project.
11. Once you have the marks in place, take a square and draw a line across the board at each mark.


12. Repeat the cuts above, using the line as your registration mark on one side and the freshly cut corner as the mark on the other, in each case lining up with the cut-mark on your fence.



13. You will now have eight large isosceles and sixteen small right triangles. Glue them in pairs, large with large and small with small. For the small ones glue the pairs back to back so that you create isosceles triangles like the large ones. Once the glue sets enough to work with, glue the pairs together, continuing until you have half circles of both the large and small triangles (four large, eight small in each half circle).
14. Take the halves to either a belt sander or a joiner and flatten the edges that will be glued together.
15. Glue the halves to make two blanks. Set them aside and allow the glue to fully cure.

Preparing the blanks for turning

1. Start by attaching a blank to a small faceplate or to a screw chuck and mounting it on the lathe.
2. Flatten the face and round the blank. I tend to use a heavy, square scraper for both operations, but whatever works for you is fine.

3. Turn an inset tenon (otherwise known as a circular groove) in the center so that this can be mounted in a chuck.
4. Flip the piece, mount it in the chuck, flatten the other face and cut a similar tenon on this side. The tenons do not need to be exactly the same size, but they do need to leave wood in the blank to house your turning. This center part will be waste and is the portion referred to as “Chuck Grip” in the “Sizing your object” section above. Be careful that you leave adequate stock to hold the piece – if your insets meet you will have a nice wooden wheel and have to start all over.
5. Remove the work piece from the lathe and cut a slot from the outside edge to the chuck grip just wide enough to hold your template.

6. Glue your template into the slot, orienting it to maximize the ease of turning. It is difficult to undercut on the inside of the blank, and nearly impossible to create a clean division anywhere but the outside. Using the duck in the drawing above, you would probably want to mount the head to the outside so that the undercut on the throat is easier to reach, but if the duck had a split tail you would need to put that to the outside so that it is not nearly impossible to create the split in the center. Spend some time thinking about the orientation before the glue sets!
7. Let the glue fully cure before moving on.

Actually turning the work

This is probably the easiest part. Just cut away your work piece down to the template on both sides. Stop frequently to check your progress and mark any areas in need of special attention. This is when you create the shape and it is important to not have any missed or rough cuts, as they will be painfully obvious in the end. I turn one side fully down to the template and then reverse the blank in the chuck. As you turn this side be careful to not cut completely through in the section right next to the chuck. Recall that the template comes to an end just before the chuck and if you hollow it completely you will end up freeing a doughnut shaped piece from the lathe, something you do not want to do accidentally. Once you have turned down to the template everywhere except at the very inside near the chuck sand down to the level you wish and free the ring holding your template. If you use a thin parting tool you can simply slow the lathe way down and cut through the blank at the inner most point of the template. This can be problematic as you will suddenly have a fairly large ring free from the chuck and your tool will be going through the center of the ring. For the safety of both you and the work you may want to saw it free rather than turning it free, particularly if your inside-most point is delicate and at risk of breaking.

Slicing your items from the blank

Once you have the piece turned and cut free of the chuck, simply draw lines across it running through the center point. These lines can be as close or as far apart as you wish, within reason. If they are very far apart you will get only a few, very wide, strongly tapered pieces. If they are very close together you will have a great number of very thin, slightly tapered pieces. Use the glue lines as guides for the other lines since they are both straight and pass through the center of the work. If you place a line on each of the glue joints they will not come back to haunt you later as they will be completely cut away. Now use the lines to cut your pieces free of the circle.

Once you have the pieces you will notice that they are tapered. If this is bothersome it is an easy thing to double side tape them to a bit of board, MDF, plywood or some such and run them through a drum sander to bring the two faces parallel. The final piece will be a bit of a parallelogram since it was created by sanding only one side of a tapered object, but it is really not noticeable in anything ¼ inch or less.

Put whatever finish you wish on them and call it done.

ADDENDUM

A note on lathe speed
One of the first things we learn to ask is “at what speed are you turning?”, shortly after we learn to ask “what is the best angle for sharpening?”. There are several good books available on sharpening so I am not going there in this note. Lathe speed, however, is a different thing. It really does matter, but we don’t get much guidance as we are starting out. When we ask at a demonstration the demonstrator must nearly always look at the lathe to see the speed and then answer. We eventually begin to suspect that the demonstrator is turning at some speed arrived at by alchemy or divination, since they too do not seem to know what speed they are running.

It is not magic but it does vary from turner to turner and from piece to piece. This is a bit of math for those interested, a bit for guidance for those in need, and a bit of amusement for the rest of us.

Keep in mind that the information below, while necessarily precise, is only for use as a guide and ***is not appropriate*** *for work that is either very small or very large.*

Why does it matter?
When we run at a low speed we reduce the probability of making a mistake, but we increase the difficulty of getting a good finish off the tool. When we run at a high speed we improve the nature of our cuts but we increase the damage done by a catch or other misplaced action. Thus each of us has a speed with which we are comfortable, and it varies with the diameter of the piece. What I propose is that you find the speed at which you reach the optimal cut/catch trade off for you measured not by RPM, but by MPH. It is, after all, the speed at which the wood contacts the tool, not the number of times it rotates that matters. For a two inch piece rotating at 800 RPM the surface is contacting our tool at just under 5MPH (4.7584MPH if precision is desired). At that RPM the rim of a twelve-inch platter is contacting the tool at just under 29MPH (28.5504MPH). So, the RPM of 800 doesn’t tell us much. If we want a consistent speed of wood peeling off the tool we would need to either slow the lathe to 133.47RPM for the twelve inch platter to attain just under 5MPH at the rim, or increase the lathe to 4,800 to get the outside of the one inch piece moving just under 29MPH. I propose the following:

Starting facts
Given that a 1” piece has a circumference of 3.14157”, a point on its surface will travel 3.14157” in each revolution. Also, we know that there are 63,380 inches in a mile and 60 minutes in an hour.

From these facts we know that an object moving 3.14157 inches per minute travels 188.4954 inches in an hour, or 0.002974MPH. So, 1RPM of a 1” piece will have a surface (rim) speed of 0.002974MPH. It is your comfortable rim speed that we are going to use to set the RPM.

Finding your comfortable rim speed
To find your comfortable rim speed in MPH, chuck up a piece of scrap of known diameter - say 3 inches. Turn up the lathe until you are just a bit uncomfortable working on it and back it off until comfort returns. Note the RPM. Using the following, calculate the MPH at the rim:

MPH at the rim (surface) = RPM X Diameter X 0.002974.

What to do with this
Using your favorite rim speed, say 15MPH, divide that number by 0.002974, in this case yielding 5043.712. Round this to a convenient number you can remember, call it 5,000 in this case. This is now your constant.

When you chuck up a piece, simply divide your constant by the diameter of the piece (in inches) and set your RPM to that number. The rim will meet the tool at (very close to) 15MPH, your comfortable speed.

Limitations
My constant is roughly 7,500, a bit over 22MPH. This indicates that I should turn a half-inch spindle at nearly 15,000RPM, clearly foolish since my lathe only goes up to 3,500 and anything going 15,000RPM on a wood lathe would scare the wits out of me because these machines are simply not designed to run at router speeds! However, a 12 inch platter at 625RPM for the rim and faster as I move to the center makes sense, as does a 3 inch short spindle at 2,500RPM. It provides a convenient starting point, not a hard rule. Use it accordingly.

Footnote
Looking back over this I find another way of adjusting RPM, they way I, and most of the experienced turners I know, use. Look to the section on *finding your comfortable rim speed*. In the instructions it says "Turn up the lathe until you are just a bit uncomfortable working on it and back it off until comfort returns". That is the alchemy the demonstrator is using; they are running the lathe at the highest speed they can while they remain comfortable with the work. The actual RPM is not important once you begin thinking about the turning itself more than the mechanics of the process. As Rude Osolnik is purported to have said when asked how one becomes a master turner, "*stand at a lathe*". With practice comes comfort and with comfort comes a feel for the proper speed. At that point you are in the group for which the math above is simply an amusement. Welcome.