INSIDE-OUT TURNING

Bob Muir, August 2003

Equipment and materials needed:

Double sided tape (optional, see *Assembly* below)
Strapping tape (optional, see *Assembly* below)
Calipers (if precision is desired)
Vernier calipers (if precision is desired)
Clamps
Combination square (if precision is desired)
Glue
Turning tools: skews, spindle & bowl gouges, hollowing tool, parting tool, etc.
Sandpaper
Four identical billets of square cross-section wood to make up the piece

Photos 1

The General Procedure:

1. Assemble the 4 square billets as shown in Photo 2.
2. Turn the desired shape into what will be the inside of the piece.
3. Disassemble the piece, rotate each billet 180 degrees about its longitudinal axis, and glue the pieces together.
4. Turn the desired outside shape and finish

Preparation: The four square billets must be *identical in size and perfectly square*. I used a table saw to trim four billets to have ***identical, square*** cross-sectional areas. The width of each billet should be equal to one-fourth (or a bit more) than the diameter of the final turning. The length should allow for a fair amount of waste at each end. Otherwise, you will be working very close to the edges of the square ends when you turn the outside.

You might want to use a jointer to smooth the surfaces to achieve tight (invisible?) glue joints.

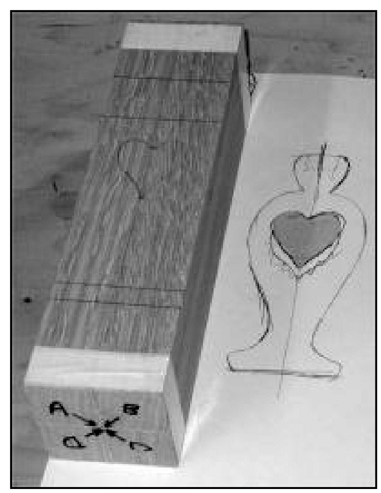


Photo 2

Introduction: The hardest part about inside-out turning is visualizing how things are going to look when finished. The next hardest is figuring out a design that will take advantage of the transverse "through-holes" (or windows) and also have a satisfactory appearance. See the Appendix: AN ATTEMPT TO HELP VISUALIZE INSIDE-OUT TURNING WINDOW SIZE.

Assembly: The billets must be held together tightly so that the assembled block can be mounted on the lathe for turning what will be the inside surfaces of the final piece. After that turning is completed, the billets are separated, rotated 180^{o} about their longitudinal axes, and reassembled for the final turning of the outside shape. Photo 2 shows the assembled block along with a design sketch. I used double-stick Scotch tape to hold the billets together while I tightly wrapped the ends with filament packing tape. This makes it very easy to disassemble the block.

Some people drill crosswise through the ends of the billets and use bolts to hold them together (see Darlow, p120). I don't think that I want to have protruding bolts flying past my hands. The square corners get one's attention, but probably won't hurt as much as bolts if your fingers get in the way! I haven't tried using bolts, but I think it would require extra time and care to be sure that the drilled holes will provide proper alignment for the final assembly.

Some people glue the billets together (with paper between them) at the ends and then have to split them apart. I followed this procedure a couple of times (without paper) and had some problems splitting the billets apart cleanly.

Some people construct one (or two) square "cup" chuck(s) to hold the ends together while turning.

Turning the "inside": Photos 3 and 4 show the completed turning of the "inside", i.e., what will be inside the final piece.

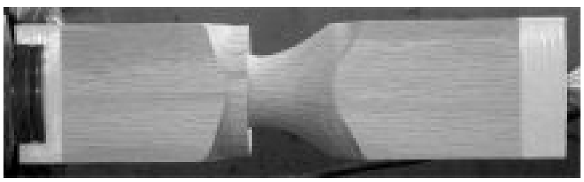


Photo 3

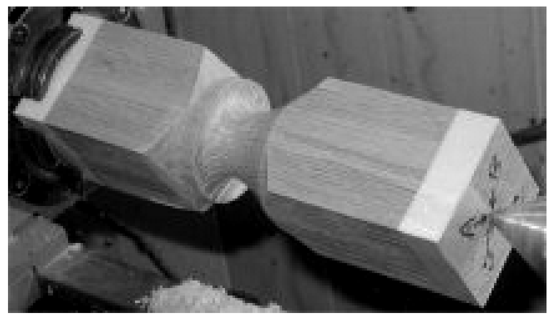


Photo 4

Concerns & issues to keep in mind while turning the "inside" include

1) The flat surfaces are the glue surfaces for the final assembly, so the more surface the better.
2) The inner axis of the assembly for the "inside" turning must be very accurately centered on the axis of the lathe. If it isn't, then one or more areas will still be flat when the other "sides" are round. This will cause problems. At least the "windows" will not be all alike.

   To aid in centering, I used a piece of sandpaper on a flat surface to chamfer (remove a little off wood) the two edges of each billet that would be at the center of the assembled block for "inside" and outside turning. The arrows in the photos 2 and 4 are pointing to the small "centering hole" formed by these chamfers.
3) The radius of the turned cylinder in the region that is to have "windows" into the interior of the final piece is equal to the width of the billets. If the billets do not have the same width, there will be problems. Anywhere the piece is turned to a radius less than this will appear as a "window" (or an unwanted gap) in the final piece. See Photo 5 for an example of unwanted gaps. This occurred because I turned the regions above and below the heart shaped window to a cylinder and went too deep!
4) If the outside is turned (rather than left flat), the width of the windows will increase as the final radius is made smaller. Let's calculate the width of the window as seen on the flat outside. The width of the window (Photo 5) will be equal to the depth of the cut below the flat surface when turning the "inside". Note that the diameter of the remaining wood (as seen in Photo 3) will be $2 \times (w$

– *d*), where *w* is the width of a billet and *d* is the depth of the cut from the flat surface.

Since the cavity (as seen in Photo 5) increases in diameter below the surface, the window will become larger as more of the cavity is revealed while turning the outside below the flat surface. This is a small effect at first and increases the smaller the outside radius is made. As can be seen in the last two drawings in the Appendix, if the final, outside diameter in the rightmost drawing is decreased, the size of the window doesn't increase very much. There will be a greater effect, if the diameter in the leftmost drawing is decreased.

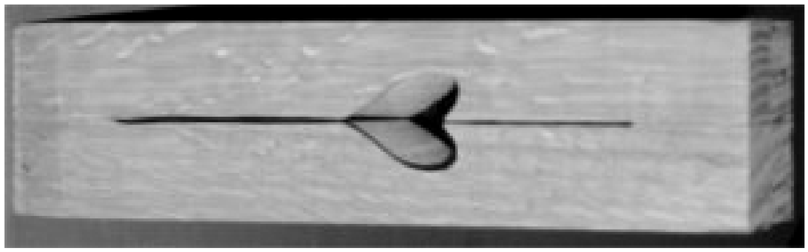


Photo 5

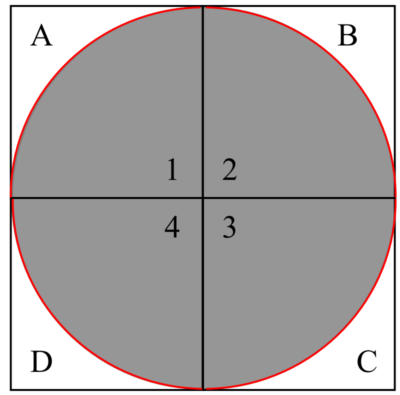
5) Turning the outside is simply spindle turning. However, you must keep an eye on the relationship between the outside and internal shapes so that the walls do not become too thin. Once the outside shape is completed, part off and finish turning the base as you usually do.

References:

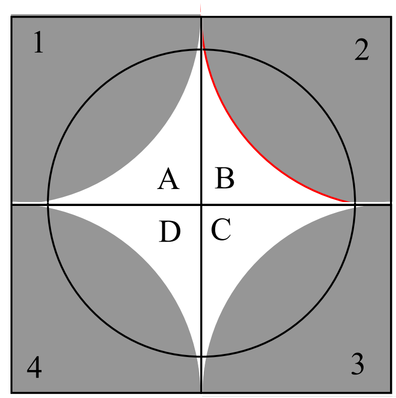
1. **WOODTURNING METHODS**, Mike Darlow, The Melaleuca Press, Exeter, N.S.W. Australia, 1999, ISBN 1-56523-125-2.
2. **Making Fancy Ornaments using the inside-out technique**, Ken Grunke, November, 2002, http://www.crwoodturner.com/ornaments/ornaments.pdf (Coulee Region Woodturners, LaCrosse, Wi.
3. **Turning a "Carved" Vase**, Ellis Hein, http://www.woodturns.com/articles/projects/carved_vase.htm
4. **Michael Kehs**, June 2000 demonstrator at Lehigh Valley Woodturners. Article in their June 2000 newsletter http://lehighvalleywoodturners.org/page2.html

APPENDIX
AN ATTEMPT TO HELP VISUALIZE
INSIDE-OUT TURNING WINDOW SIZE

First, in the region (lengthwise) where to "windows" are to appear, turn to "round" with radius = width of side of billets. The cross-section of remaining wood will be as shown shaded in the drawing to the right.
The squares are the ends of the billets.



If the billets are perfectly square and perfectly aligned and are now rotated 180^{o} about their longitudinal axes so that the letters are in the center of the piece, the cross-section of the turned region will look like the second drawing where the shaded region is wood and the white region is where the original wood was turned away.
As can be seen there will be no "windows" in the flat outside surfaces.



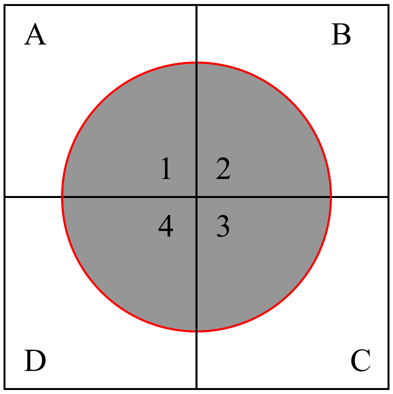
The circle shows that, if the piece is turned to that radius, there will be very small windows on each side of the piece.

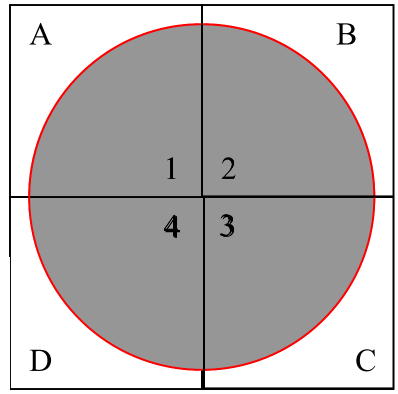
The drawings in the next page attempt to show the results on the window sizes from the first ("inside") turning to two different radii.

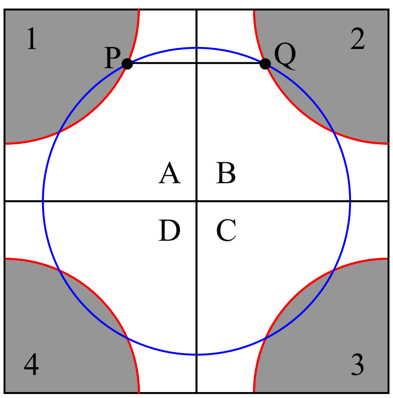
The two upper drawings below show an end view of two different radius cross sections made while turning the “inside” of the piece.

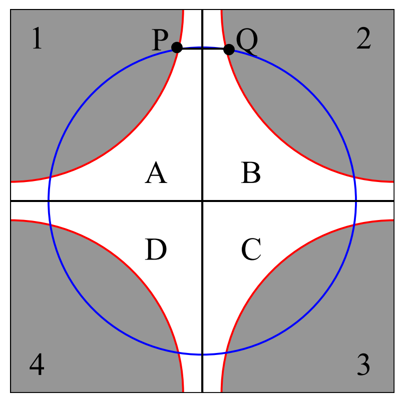
“Inside” turning removes much wood. “Inside” turning removes little wood.

Shaded sections are the remaining wood.









The two lower drawings are an end view of the cross sections after the billets have been rotated 180^{o} about their longitudinal axes. The shaded sections show where there is wood, white sections are empty space. The circle shows the turned diameter of the “outside” turning. The “window” width is the part of the circle between the solid sections, i.e., the line PQ. The circles are the same diameter in both drawings.