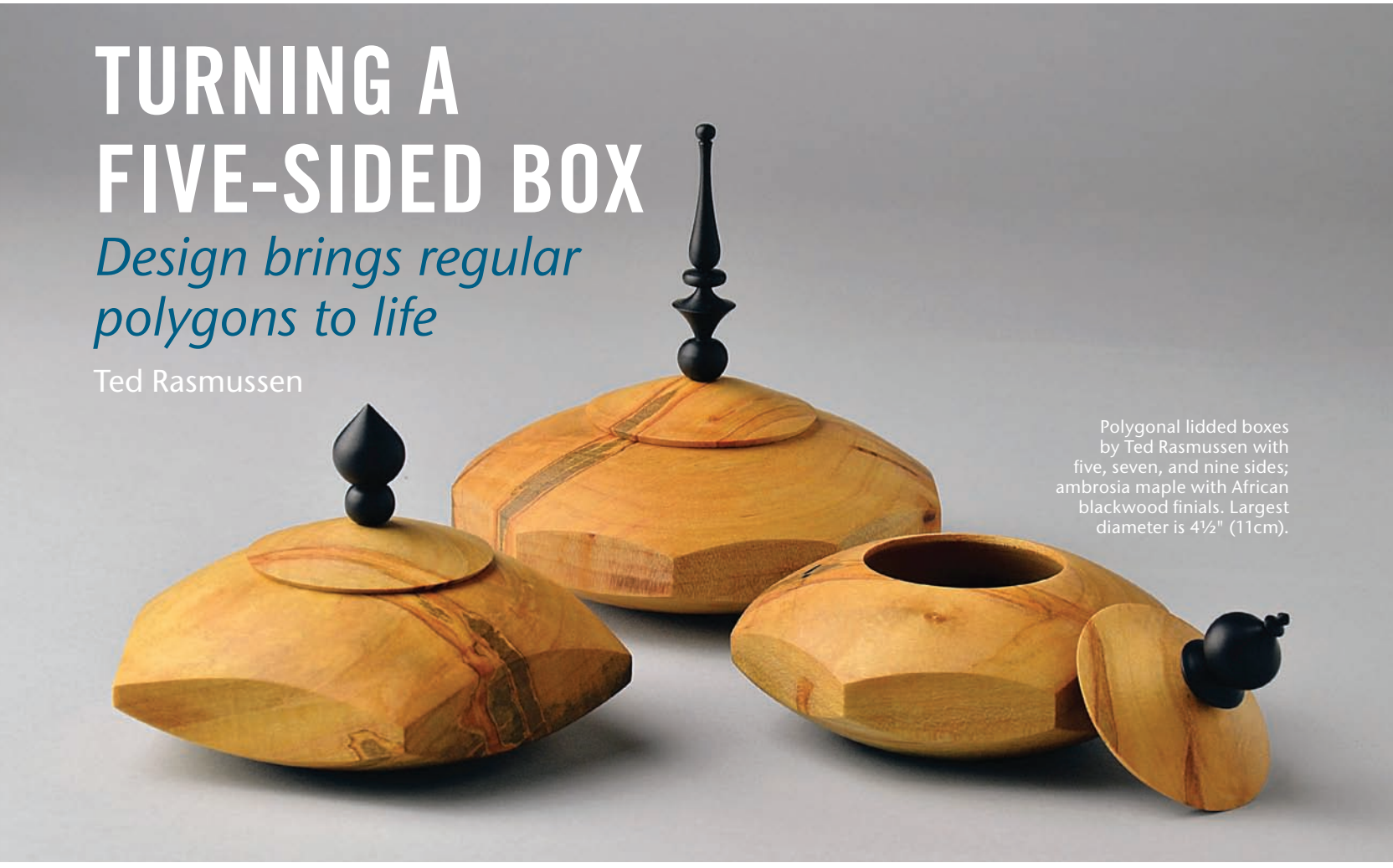
TURNING A FIVE-SIDED BOX

Design brings regular polygons to life

Ted Rasmussen



Polygonal lidded boxes by Ted Rasmussen with five, seven, and nine sides; ambrosia maple with African blackwood finials. Largest diameter is 4½" (11cm).

My favorite turnings are small- to medium-sized jewelry boxes with lids, in either endgrain or sidegrain orientation. When I wanted to incorporate a unique design, it dawned on me that my love for applied geometry might contain the answer.

Applied geometry includes geometric constructions such as regular polygons, which you may remember from a high school drafting course. I envisioned a series of polygonal vessels, turned top and bottom but with flat sides. The flats would make the design unique, and the turning would still be done about a central axis. The key would be to saw the flats first, before going to the lathe, not after completing the turning.

Excited by the prospect, I began drawing pentagons, hexagons, heptagons (seven sides are difficult), and octagons. After turning several lidded vessels based on regular polygons, I saw that shaping the top and bottom of the vessel defined the flat sides of the polygon with beautiful catenary curves. I will explain turning a five-sided vessel (pentagon) with a lid and finial, but you may want to try turning one with six, seven, eight, or nine sides.

This project will introduce you to turning intermittent wood and air, to the basics of hollowing, to using a jam chuck to remount work on the lathe, and to turning a finial. Completing this project will not only give you a sense of accomplishment, but also will add significantly to your woodturning repertoire.

Prepare the stock

The *sidebar at right* explains how to draw a polygon with any number of sides using a protractor and a straightedge. Make a pattern by laying out the size polygon you want on a piece of stiff paper. For our pentagonal vessel, I suggest sides of about 2½" to 3" (6cm to 8cm) in length. A 4½"- (11cm-) diameter circle will yield a 2¾" (7cm) side, and a 5"- (13cm-) diameter circle will yield a 3" side. These lengths are approximate.

To demonstrate this project, I chose 1¾"- (4cm-) thick spalted maple for the vessel and lid, with a 1" (25mm) square of African blackwood for the finial. I chose blackwood for its lovely contrast

Mount the blank

Carefully saw the polygonal blank. Saw just outside the layout lines.

Center-bore the blank for mounting on a worm screw held in a scroll chuck.

Thread the blank onto the worm screw, tight against the chuck jaws.

Drawing Regular Polygons

I remember from my high school mechanical drawing class an assignment to draw regular polygons such as a pentagon, hexagon, or octagon. It's not hard to do with a little know-how. A regular polygon is a closed figure composed of straight lines with equal corner angles, equal central angles, and sides of equal length. Regular polygons can be inscribed within a circle or circumscribed around a circle.

Find the central angle

You can find the central angle of a regular polygon by drawing lines to the center from two adjacent vertices and measuring with a protractor (*Photo a*). Since there are 360° in a circle, you can calculate the central angle of a pentagon by dividing 360° by five, for 72°.

Find the corner angle

To find the corner, or included angle, you can use a formula from high school geometry, where N is the number of sides:

$$\frac{(N-2) \times 180°}{N}$$

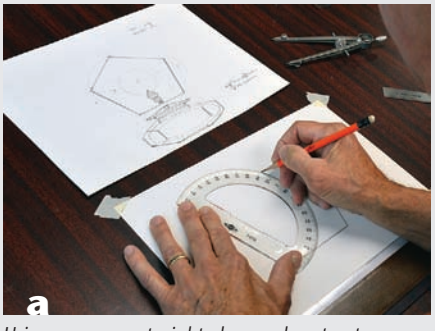
For a pentagon, N=5, so the calculation would look like this:

$$\frac{(5-2) \times 180°}{5} = 108°$$

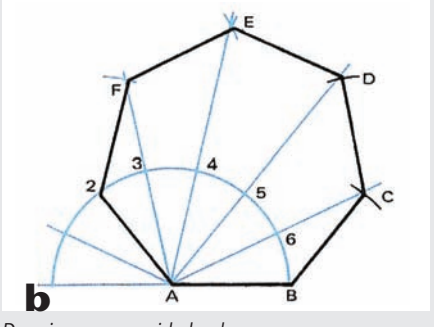
Draw a seven-sided polygon

While there are strict compass-and-straightedge constructions for regular polygons, it is simplest to use a protractor. The following steps show how to draw a polygon with seven sides (*Photo b*); you can follow this same procedure for polygons with any number of sides. In this case, the length of the side is given as AB.

1. With radius AB and A as the center, draw a semicircle and use the protractor to divide it into seven equal parts. Each segment has a central angle of 180°÷ 7, or 25.7°.
2. Draw radial line A2 through the second division.
3. Extend radial lines through points 3, 4, 5, and 6.
4. With AB as the radius and B as the center, stop line A6 at C.
5. With the same radius and C as center, stop line A5 at D. Repeat for E and F.
6. Connect the points with straight lines as shown.



Using compass, straightedge, and protractor, you can draw regular polygons of any size with any number of sides.



Drawing a seven-sided polygon.

with the maple. Whatever wood you choose, I recommend a thickness of around 1¾".

Transfer your polygon pattern to the wood, then cut it out on the bandsaw (*Photo 1*). With a steady hand, cut the lines outlining the polygon as straight as you can. Leave the wood rough from the saw because there will be less of it to sand after you turn the vessel. Saw the round, 3½"- (9cm-) diameter lid blank from the same wood.

There are several methods for holding stock for turning, but since this is a sidegrain project (where the grain is running perpendicular to the ways of the lathe), I chose to use the worm screw that was supplied with my Oneway chuck. It requires boring an 11/32" (9mm) mounting hole ¾" (19mm) deep in the center of both blanks (*Photo 2*). Drill the hole in what will become the top, or opening of the vessel; you will eliminate the hole later when you hollow the vessel. Chucks vary, so install the jaws that will hold the worm screw in your chuck (No. 2 jaws for me) and securely thread the stock onto the screw (*Photo 3*). ▸

Turn and hollow the vessel

True the face of the blank. I use a ⅜" (10mm) bowl gouge to prepare it for laying out the foot and chucking recess. A comfortable recess measures 1⅜" (35mm) diameter by 3/16" (5mm) deep. Begin the recess by cutting straight in with a parting tool to the required depth. Align the parting tool with the ways below to ensure a cut that is perpendicular to the face of the blank. Then use a small bowl gouge, cutting from outside to center, to create a flat bottom inside the recess. Now cut a small, flat foot extending about ⅜" out from the recess. Define the outside of the foot by cutting straight in about 1/16" (1.6mm) with the parting tool (*Photo 4*).

Use a small bowl gouge to shape the convex bottom from the foot to the flats you cut earlier on the bandsaw (*Photo 5*). This cut will transform the straight bottoms of all the flats into blended catenary arcs reaching upwards around the vessel. Sand the recess, foot, and curved bottom using the grit sequence of your choice, smoothing to 400-grit abrasive. To complete the turning of the vessel bottom, check the foot with a straightedge to be sure it is flat.

Remove the worm screw and its jaws from your chuck and install jaws that will fit inside the recess (No. 1 jaws for me), using the chuck in expansion mode. Decide how big you want the opening in the top of the vessel to be; it is 1¾" diameter in the photos. Lay the radius out from the center and draw the circle indicating the opening diameter (*Photo 6*). Locate the opening by cutting straight in with a parting tool about ¼" (6mm) deep, then use a bowl gouge to remove just enough wood to establish the opening (*Photo 7*). Now continue with the bowl gouge to turn a smooth convex curve from the opening down to the flats. You will be turning air between the flats and will need to control the gouge by pressing it tight on the toolrest. Shaping this curve will require more than one pass. Sight the profile from the edge of the workpiece to compare the symmetry of the cuts from the foot and top of the vessel (*Photo 8*).

The interior is easy to hollow because it is not too deep and the opening is relatively large. I use several inexpensive bent-tip hollowing tools and a round-nose scraper. Begin by cutting straight in with a round-nose scraper, then move the tool to the left to remove most of the wood, paying close attention to the depth of the cut. I try for a bottom thickness of 3/16". Next, use an angled or bent-tip hollowing tool, or any small hollowing tool you have, to remove wood from the interior sides, blending the cuts tangent to the bottom and up to the rim of the opening. I have found that a slight negative rake works best to remove wood with few catches, achieved by raising the toolrest up a little so the tool handle is higher than the cutting tip (*Photo 9*). Stop often to check the depth of cut and

Shape the vessel's bottom half

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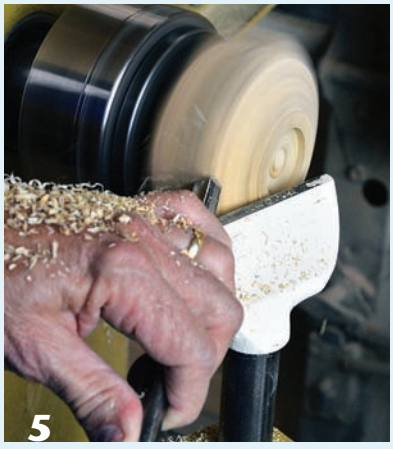
Part a shallow groove to define the foot of the vessel, about ⅜" outside the chucking recess you'll need for remounting later.



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Use a small bowl gouge to shape the vessel's underside. With the grain perpendicular to the lathe axis, "downhill" goes from small diameter to large.

Shape the vessel's top half

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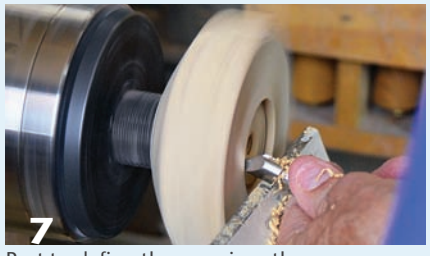
Remount the work via the chucking recess so you can lay out the vessel's opening around the worm-screw hole.



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Part to define the opening, then remove the first layer of waste with a bowl gouge.

8

Shaping the vessel creates beautiful catenary curves along the flat sides.

Hollow the vessel

To hollow smoothly with a bent-tip tool, position the toolrest slightly above the lathe axis and raise the tool handle.

Gauge the depth of the vessel with a pencil and aim for a 3⁄16" (5mm) bottom thickness.

Your fingers are the most sensitive calipers for evaluating wall thickness and smoothness.

gauge your progress using your most sensitive calipers—your fingers (*Photos 10, 11*). Continue hollowing until you achieve a smooth, uniform surface with no ridges. Complete the interior of the vessel by sanding at a slow (safe) speed using the grit sequence of your choice, smoothing to 320-grit abrasive.

There are several ways to sand the flat sides smooth. You can leave the vessel in the chuck and hand-sand with abrasive wrapped around a block, or take the workpiece to a stationary disk or belt sander. I prefer the latter option because it is quick. Hold each flat side parallel to the disk or belt and make several quick contacts with the abrasive to remove the ridges left by the band saw. Finish the sanding by hand.

Turn the lid

The lid blank is extra thick, so there is plenty of material for you to thread it onto the worm screw, turn the lid, and part it off. Begin by truing the exterior of the lid stock and laying out the opening diameter. I use Vernier calipers to take an accurate measurement of the vessel's opening. I like the lid to have a gentle ogee curve from the edge up to the finial, with the lip beveled at about 45°.

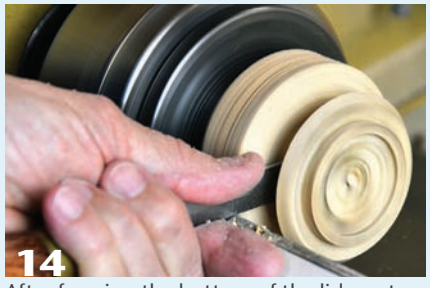
First, use a sharp parting tool to turn the tenon of the lid to fit the opening of the vessel. Make the tenon about 3⁄16" long. Remove wood incrementally so you can sneak up on a tight fit, and stop often to check the fit of the tenon with the vessel opening (*Photos 12, 13*).

Use a small skew or spindle gouge to undercut the lid several degrees so that when the lid rests on the vessel, it will conform to the vessel's convex shape. Check the fit of the undercut against the vessel's top surface several times while completing this cut. When you are satisfied with the fit, create a slight dome on the underside of the lid (inside the tenon) so it is not flat. This is a subtle feature often overlooked on vessel lids. Part off the uncompleted lid, leaving enough material to turn the ogee shape on the top of the lid. I like to stop parting midway and complete the cut with a coping saw (*Photo 14*). ▸

Turn the lid

Mount the lid blank on the worm screw, then use a parting tool to size a tenon that fits snugly into the vessel's opening.

Check the fit often by offering the box opening up to the lid tenon.



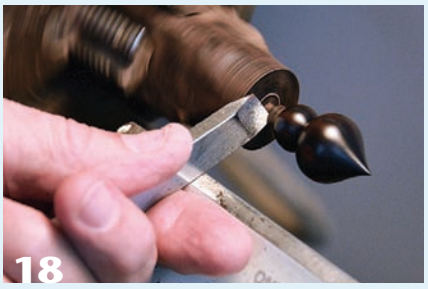
After forming the bottom of the lid, part it off the blank. Be sure to leave enough wood for its top surface.

Remount the lid in a jam chuck so you can cut a gentle ogee on its top surface.

Turn the finial

Shape the finial with a small gouge.

Evaluate the finial by holding the vessel and lid up to it, and keep turning until you like its size, shape, and proportions.



Form a small tenon on the base of the finial, then part it off.

To remount the lid so you can complete its top surface, true up the remainder of the blank still in the scroll chuck, and make it into a jam chuck by cutting a tight recess for the lid tenon. After a light final sanding of the vessel opening with 400-grit abrasive, take an accurate measurement and cut a matching recess in the jam chuck. I like the fit to be so tight that I have to tap the lid tenon into it. Once the lid is secure in the jam chuck, use a small bowl gouge and ride its bevel to cut a gentle ogee curve from the edge of the lid to its top (*Photo 15*). The bowl gouge leaves a smooth surface. You might choose to shape the lid with a round-nose scraper, but you would have more sanding to do.

Complete the lid by drilling a hole to accept the finial. Mount a drill chuck in the tailstock with a ¼" Forstner bit and bore a 3⁄16"-deep hole.

The lid might be too tight in the jam chuck to remove with your fingers. If so, it may be necessary to use a chisel and mallet to split the jam chuck.

Turn the finial

Remove the worm screw from the chuck and install the chuck's smallest jaws for holding the finial blank. I used a 5" length of African blackwood for the finial because it complemented the maple vessel and lid so well. No matter what stock you use, it is important to cut the blank square so the jaws of the chuck make good contact and grip it securely.

After roughing the finial stock into a cylinder, shape the finial to your own design or imitate the onion top (zwiebelturm) that I used for this vessel. Use a small gouge to cut the onion top shape, cutting carefully down to the sharp but delicate point (*Photo 16*). I turn the bottom half of the onion with a small bowl gouge but complete it with a skew or the sharp tip of a parting tool when the skew is too large to engage properly. A parting tool makes an excellent skew and its small cutting edge makes sense in tight situations. I cut the smaller sphere below the onion top with the skew and parting tool combo as well. I like to compare the size and proportion of the finial with the vessel as I cut it down to a size that looks right (*Photo 17*).

A tenon on the base of the finial will fit into the recess you drilled into the top of the lid earlier. To form the tenon, use a sharp parting tool to carefully scrape away wood, reducing it down to a calipered ¼" diameter. Sand the finial to 400 grit and polish it on the lathe using paste wax. Mark the length of the tenon at 3⁄16" and carefully cut the finial off using a skew or parting tool (*Photo 18*). Skillful turners with years of experience will cut all the way through and catch the finial in one hand. A safer method is to cut almost all the way through, stop the lathe, and twist the finial off into your hand.

Check the fit of the finial, making sure its lowermost feature comes in full contact with the lid surface. If necessary, shorten the tenon slightly with sandpaper. Assemble all three parts and give your work a final inspection before gluing the finial into the lid.

I used Danish oil on the vessel and lid because I like the medium satin sheen it produces on most woods. ■

Photos by John Kelsey.

Ted Rasmussen, a retired industrial arts teacher with thirty-two years of service, is an active member of the Lancaster Area Woodturners in Pennsylvania. He is a past president, current board member, and chair of the standards committee of the Lancaster Designer Craftsmen, a local chapter of the Pennsylvania Guild of Craftsmen. Ted was invited to teach at the John C. Campbell Folk School in 2013 and will return for another stint in 2015.