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Part II: How to turn a goblet

Multi-Axis Turning

By Barbara Dill

The stem of the goblet at *right* incorporates an arc-type spindle with two parallel axes. The goblet at *left* includes a circular-type spindle with three axes on the bottom and one on the top.

In the Fall 2007 issue, a conceptual model was described to help woodturners think about what to expect when turning a multi-axis spindle.

In a nutshell, there are two basic results or outcomes when changing the axes. First, when the new axis is partially cut, the result is two or more arcs that intersect. This results in a circumference made of intersecting arcs (**Photo A**). Alternatively, if the new axis is turned to a cylinder, a bead or cove is created with a circular or oblong circumference (**Photos B** and **C**).

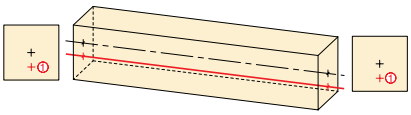
The variables that create the desired result are the type of curve or line cut and the way the axis is placed. Axes can be parallel or twisted as shown on drawings *below right*. What makes all this interesting are the endless combinations each type of axes offers.

With some of the principles defined, it's time to move on to the how-to samples to see some of the different outcomes possible. For more help in executing multi-axis pieces, refer to Part I of this piece in the Fall 2007 issue, "Multi-Axis Turning" and "8 Strategies for Success" on *page 57* in this issue.

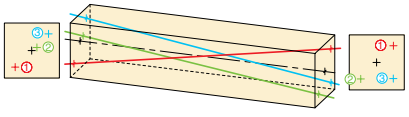
Get started

The tools required for this type of project are the same lathe tools required for routine spindle work: ¾" spindle roughing gouge or a ½" bowl gouge sharpened like a roughing gouge, and a detail or spindle gouge. (By grinding your tools to a 30-degree angle, you'll improve your ability to make sharp V-cuts.) At the lathe, you'll need a 4-prong drive center or cup drive and a live tail center with a cup.

PARALLEL AXIS



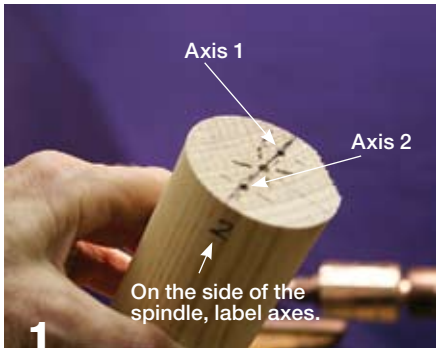
TWISTED AXIS



Arc-type spindle, 2 parallel axes

Use your spindle roughing gouge to reduce the 2×2×9" stock to a cylinder, using the true center axis. Next decide what axes you'll use. The distance of each axis from the center axis is important as is the type of axis (either parallel or twisted). While the spindle is still sturdy, press all axes points into each end by clamping them between the head- and tailstock. Then mark the axes on both ends and on the cylinder side (**Photo 1**). It helps to write down the

An arc type spindle with two parallel axes shows the cove, bead, and cove .



Press the axes into the wood and number the sides and the ends of the spindle.

sequence of the axes that you'll use and to keep the note at the lathe for reference.

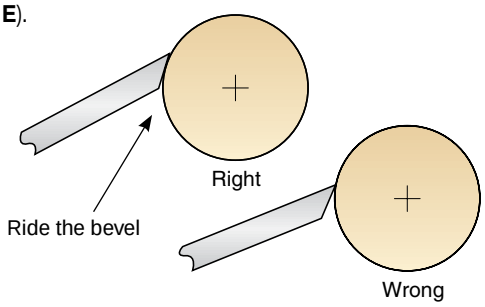
Place the spindle in the Axis 1 center points, which should be the same direction and distance from the center axis at both ends. When you cut a bead and cove ***only*** in the air wood (the shadow you see when the lathe is turning), you create an arc in the spindle (**Photos 2** and **3**).

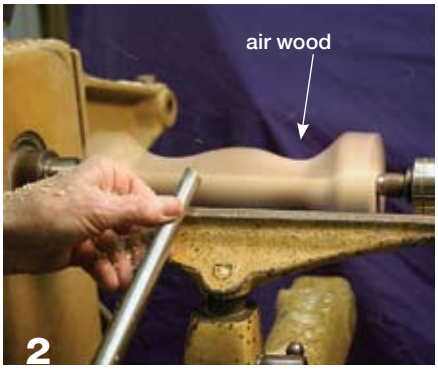
Change to the parallel axis (Axis 2) on the other side of the true center axis. To help visualize the outcome, draw a reference profile. (**Photo 4**). On this new axis, turn a bead, a cove, and a bead (**Photo 5**).

Skills to Get Started

If you can execute these basic spindle-turning techniques, you will have success with multi-axis turning. You can do it!

- The bevel of the tool rides on the wood, making the tip high on the cylinder. Be sure to ride the bevel. When cutting air wood, you'll be challenged to make a clean cut because your gouge bounces on and off the hardwood.
- When making a cut to the right of the bead, the spindle gouge must point to the right and the right tip of the tool is cutting the wood (**Photo D**). When cutting to the left, point the tool to the left and the left tip of the tool is cutting the wood (**Photo E**).
- Lathe speed is an important factor in successful multi-axis turning. A fast speed gives the tool less time to bounce, since the tool sometimes touches wood only a fraction of a revolution. I run my variable-speed lathe at about 3,000 rpm. Light cuts improve your work.





When the lathe is running, a shadow (air wood) is revealed. Turn the air wood only.

On Axis 1, turn two beads and a cove with a spindle gouge.

With a pen, mark the wood that turning on Axis 2 will remove from the spindle.

With the lathe stopped, the Axis 2 changes are evident on the spindle.

Photo 6 shows how this looks while turning the air wood. When complete (**Photo 7**), a delicate multi-axis spindle appears between centers.

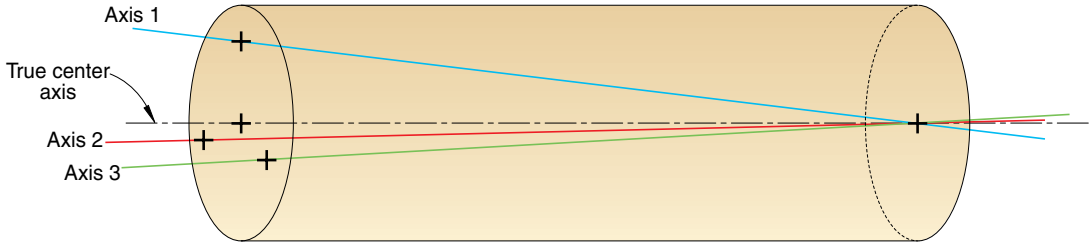
Circular-type spindle, 3 twisted axes

With a spindle roughing gouge, turn the 2×2×9" hardwood stock to a cylinder. Press and number the axes. As shown in **Photo F** and the drawing at *right*, this spindle has three axes on the left (near the headstock) and one on the right (tailstock). Mark reference numbers on the side of the cylinder.

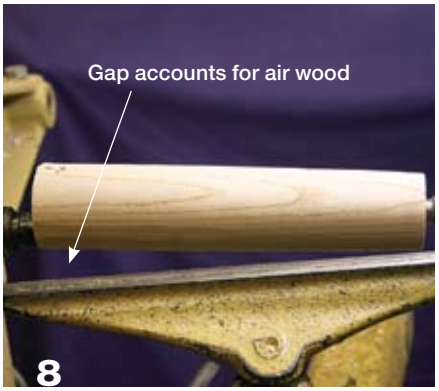
This circular-type spindle includes three twisted axes.

With the lathe turning, the air wood takes on a different profile.

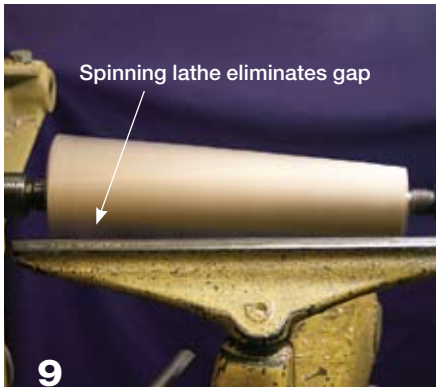
When complete, the turning on Axis 2 reveals a delicate spindle.



Set up for a circular-type spindle with 3 twisted axes



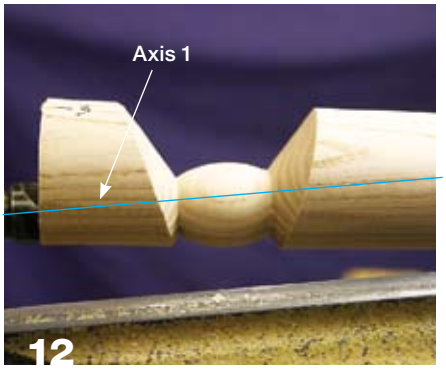
After mounting the spindle for Axis 1, adjust the tool-rest position (gap at left).



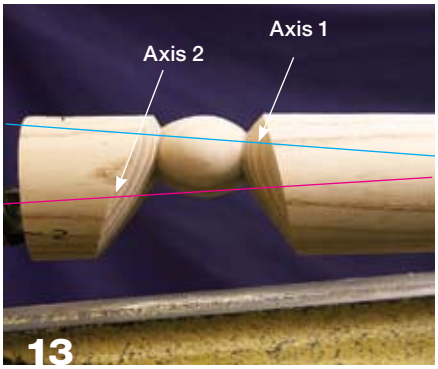
When the lathe is turning, the gap between the tool rest and air wood disappears.

With a spindle gouge, remove all of the air wood and turn a cylinder.

Position the tool tip high on the wood, which will allow the bevel to contact the wood.

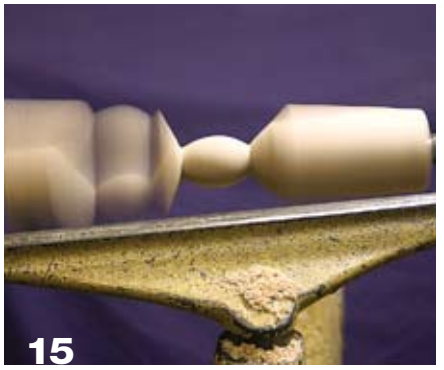


Complete the bead in Axis 1. To keep the details sharp, use cloth-back sandpaper.



Move to Axis 2. Turn the spindle by hand to verify that the tool rest won't hit the spindle.

When beginning to cut the second bead, take light cuts to avoid catches in air wood.



While turning the second bead in Axis 2, the bead created on Axis 1 will be a blur.

On Axis 3, the first two beads (Axes 1 and 2) will be blurred.

On Axis 3, make a V-cut. Because you're contacting air wood, light cuts work best.

Return to Axis 1 (your fourth position) to make a V-cut at the tailstock end.

The first bead is in the same plane as the V-cut, which explains why it isn't blurred.

For Axis 1, turn the spindle by hand and set the tool rest. The gap between the cylinder and tool rest should be greater at the headstock end (**Photo 8**). With the lathe running, the solid wood and air wood will close the gap at the left end of the tool rest (**Photo 9**).

With a ½" spindle gouge, turn a new cylinder and remove all the air wood. Now, turn a bead on this cylinder (**Photos 10** and **11**). To do this, keep the bevel in contact with the spindle, and use the tip to turn the bead. Use light cuts. See "Skills to Get Started" on *page 53*. Sand the cylinder and bead smooth (**Photo 12**). Use care when sanding to avoid the air wood whacking your knuckles.

Place the spindle on Axis 2. The first bead is now part of the air wood (**Photo 13**). Now turn the new cylinder on this axis and turn a second bead (**Photos 14** and **15**). After you sand the bead as previously described, place the spindle on Axis 3 and make a V-cut, removing stock all the way into solid wood (**Photos 16** and **17**).

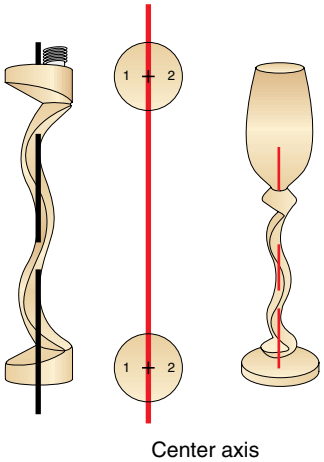
Return to Axis 1 to turn another V-cut on the tailstock (right) end. To verify you're on Axis 1 centerpoints, you should see the first bead clearly (**Photo 18).**

Notice in **Photo 19,** the first bead and the V-cut are not blurred. This confirms they were turned in the same plane.

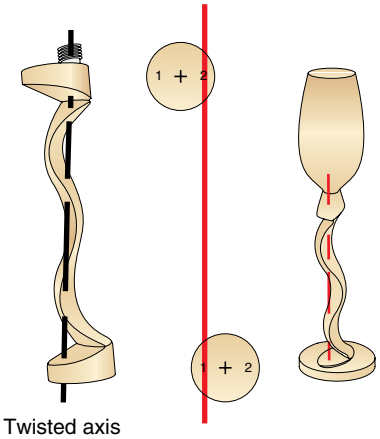
The ends are resolved at the center axes of both ends.

The ends are resolved using the opposite (twisted) axes.

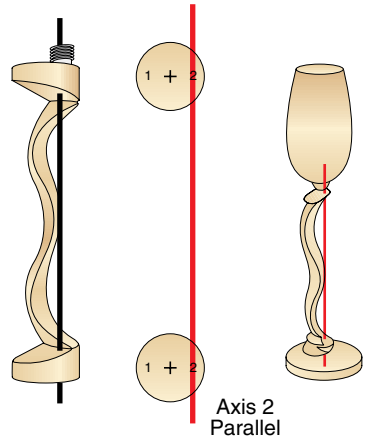
The ends are resolved using the same parallel axes on both ends.



Center axis



Twisted axis



Axis 2
Parallel

Design options

The next step is to create ends that transform the spindle into a goblet, a candle cup, or some other object.

The goblets *above* are just three options that align the arc-type spindle with a base and goblet cup (**Photos 20, 21,** and **22**).

Refer to **Creating the Goblet** *opposite* for the techniques you'll need to make to turn and fit a cup and base to the stem. The accompanying example (**Photo 23**) includes the steps for a circular-type spindle *opposite*.

Apply a finish

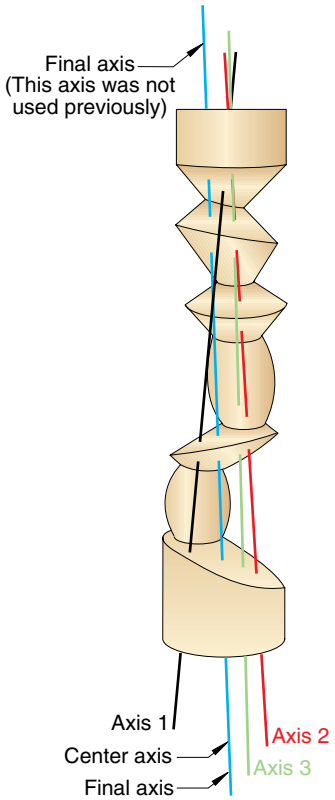
For the inside of the cup and the lip, apply thin cyanoacrylate (CA) glue. I've had good results swirling CA inside the cup with a ¾"-diameter ball of waxed paper held in a hemostat. Then I quickly mop up the excess CA with a ¾"-diameter ball of paper towel held in a second hemostat.

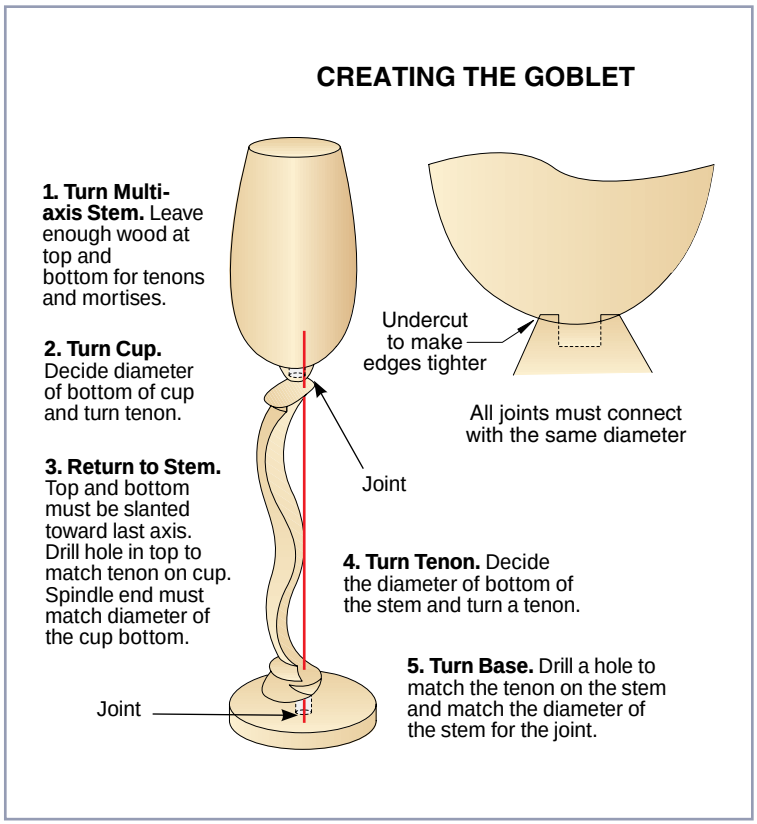
After the CA glue dries for a day or two, sand smooth with 400-grit sandpaper or Micro-Mesh and apply a second coat of thin CA. Repeat the steps.

On the outside of the goblet I use various finishes depending on the desired lustre and wood species. I've used CA glue on the outside and inside of the cup.

Part of the fun of turning a multi-axis goblet is putting it to use—your goblet should be more than an object gathering dust on a shelf. Toast your success!

Barbara Dill (bdill6@horizon.net) is a full-time woodturner and a member of the Woodturners Anonymous of Richmond, VA. She teaches woodturning at the Visual Arts Center in Richmond.





Illustrations: Roxanne LeMoine

This drawing is based on the circular type spindle with three axes illustrated in this article. The axis used to establish the ends on the top is a new axis halfway between the center axis. At the base, the resolving axis is the true center axis.

8 Strategies for Success

• The depth of each cut becomes critical. On a three-sided object, if one or two of the cuts are too deep, the third cut will have no space and the turning will either break or the design will change. Use the tool rest as a reference point to measure the depth of a cut.

• When turning the spindle, machine the entire length into a cylinder. If the ends are left square and turned off as the last step (after the spindle is thin), hitting the square ends can snap the turning stock.

• Create a numbering system for the multiple center points on the spindle ends. Establishing a system that you use each time will decrease confusion. However, it is hard to avoid brain cramps while doing this work. I use a thin permanent marker and also mark the sides so I can see the axes without removing the piece from the lathe. Use a notepad to record the sequence of the axes. (Note: I do not number the true center axis.)

• Need to turn again on a previous axis? Before you pick up your lathe tool, verify that you're on the correct center points by touching a piece of chalk at several points along the cylinder. This way, you'll avoid ruining turning stock with a lathe tool.

• Take notes and document the process of turning a speci□c design to help you re-create the spindle. Turning sample pieces will help you remember how that speci□c design was made.

• Catalog the samples so you can refer to the axes later. I have made boards that have all of the examples in all of the categories of variables and outcomes. I attach the sample spindles to the board using hook-and-loop tape (Velcro is one trademarked name). This way, I can take a sample to the lathe for easy reference.

• Sanding is a challenge. Aggressive sanding destroys curved surfaces and softens crisp edges and lines. Until I became comfortable with the process, I relied on rasps (lathe turned off) to smooth my cuts. Auriou #14-4" and a #13-8" are favorites.

• Cloth-backed sandpaper works best because it holds up better than paper-backed versions against the multi-axis surfaces. Sand each axis before turning the second axis.