

A systematic approach to

Multi-Axis Turning

Many woodturners find that multi-axis turning is difficult to figure out and is an even bigger challenge when trying to predict the outcome. Understanding the reasoning behind multi-axis turning is the first step to proficiency.

By Barbara Dill

For years, I've been intrigued with multi-axis spindle work. Although the candlesticks and bottle stoppers I turned were fun and whimsical, asymmetrical forms were a diversion from the symmetrical shapes I usually produced on the lathe.

My multi-axis shapes were similar—mostly beads and discs of varying construction. Candidly, I had not explored the many options that this turning style has to offer.

That all changed in the spring of 2006 when I attended Mark Sfirri's three-day workshop at Virginia Commonwealth University in Richmond. I was impressed with how Mark had taken the concept of multi-axis turning to heights I had not imagined.

Note: This is the first of a two-part series on multi-axis turning. In the Winter issue, we'll show how to create some pleasing variations. But first, some important concepts.

Now, months later, after spending many hours experimenting with these concepts, I have found a way to systematically conceptualize and categorize multi-axis spindle turning.

Two variables

Traditionally, architectural turnings are spindles made by using one axis (**Drawing 1**). When the spindle is turned on one axis, the outcome is a spindle that's ideal for a chair or an architectural feature. Beads, coves, and straight lines add visual interest.

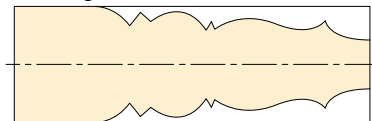
Just as traditional spindles are made by changing the shape (cutting beads, coves and/or straight lines), multi-axis spindles are accomplished by changing the axis as well as the profile:

1. Placement of the axes. One or both ends of the spindle are moved from the center axis to a different axis. The distance and direction in which the new axes are placed

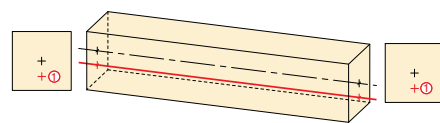


The stem of this goblet was turned from rectangular stock with two additional axes.

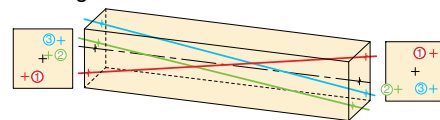
Drawing 1



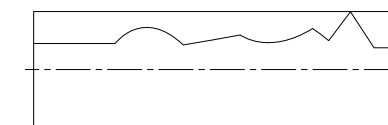
Drawing 2



Drawing 3



Drawing 4



relative to the center axis is one major variable inherent in multi-axis turning.

The axis is considered *parallel* when each end is moved the same distance and direction from the center axis (**Drawing 2**).

The axis is considered *twisted* when each end is moved in different directions and distances from the center axis. **Drawing 3** shows but one of many ways to move the axis by twisting it.

2. Line, curve, or angle on the spindle. On architectural spindles, coves, beads, or straight lines create a shape. This is true as well on multi-axis spindles (**Drawing 4**).

Predicting results

One of the challenges of multi-axis turning is predicting the result when the axis is changed or when



Each of the spindles above are circular outcomes. The spindle on the right was made with parallel axes; the rest have twisted axes.



Each spindle above is an arc outcome. The third spindle from the left has twisted axes. The other three have parallel axes.

a certain cut is made. When trying to think more clearly about this, I realized that the way to look at it was to not focus on the axis or the cut. (I tried this approach and could not make sense of it.)

I finally realized that the results or outcomes need to be seen as the primary focus, and the ways the spindle is manipulated (or what is done to the spindle or the variables) need to be seen as the factors that create the result. So, the results (the final product) depend on the things that have been done to the wood (cause and effect).

After getting past this hurdle, you can then conceptualize that there are two basic and stunning types of results that occur when turning a multi-axis spindle. Each of these outcomes can occur when using any of the various ways to mount and shape the spindle, as shown on *page xx*.

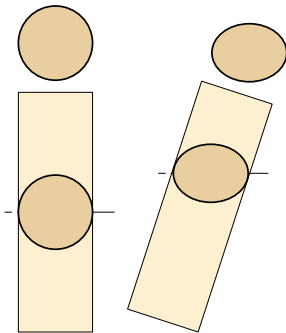
If you take a close look at the end results of many spindles, it becomes clear that the horizontal cross sections are either circular or arc-shaped. The difference is a result of whether or not the new axis has been partially cut, creating an arc, or cut deeply enough to create a cylinder.

To explore this further, look at the **circular** or oval-shaped outcomes. This occurs when the axis is turned to a fully round shape. Beads, coves, or straight

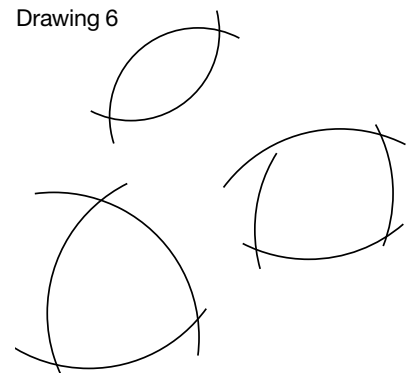
lines are then turned in the newly formed cylindrical axis. The result is that the horizontal cross section of this spindle is a shape that is a full 360-degree circle or oval. The oval is made when the cylinder is on an angular axis (**Drawing 5**).

The other category of outcomes happens when the new axis is partially turned and an arc is created. These arcs intersect, resulting in the shape of a lens with two or more points when the horizontal cross section is viewed (**Drawing 6**).

Drawing 5



Drawing 6



A goblet based on a circular-type bead (bottom) and a twisted arc shape

Outcomes

It helps to create the various types of results and keep the samples for references. The table below represents only a sampling of outcomes. If you make a board and categorize your samples, you will discover variations you haven't yet explored. This or a similar organization will help you explore design ideas.

PARALLEL AXIS

ARC TYPE

CIRCULAR TYPE

STRAIGHT LINE

1+	1+
3+	4+
2+	2+

4 parallel axes at 90°



CURVED LINE

1+	1+
•	•
2+	2+

2 parallel axes



ANGULAR SHAPE

1+	1+
+	+
2+	2+

2 parallel axes



STRAIGHT LINE

1+	1+
•	+
2+	2+

2 parallel axes



CURVED LINE

+	+	+	+
1	2	2	1
+		+	
3+			+3

3 parallel axes



ANGULAR SHAPE

1+	1+
+	+
2+	2+

2 parallel axes



TWISTED AXIS

ARC TYPE

CIRCULAR TYPE

STRAIGHT LINE

+1	+2
+	+
+2	+1

2 twisted axes



CURVED LINE

+1	1	2
+	+	+
+2		

2 twisted axes at 90°



ANGULAR SHAPE

1+	+2
+	+
+2	+1

2 twisted axes



STRAIGHT LINE

+	+	
1	4	+
2	3	
+	+	

4 twisted axes



CURVED LINE

1+	+2
+	+
2+	+1

2 twisted axes



ANGULAR SHAPE

1+	+2
+	+
+2	+1

2 twisted axes



This side of the chart contains samples in the category of outcomes in which the horizontal cross sections are arc-shaped. This happens when the axis is changed and the cut merely forms an arc shape on the wood rather than going deep enough to create a cylindrical shape. All the variables can be used to create this outcome.

The examples above include samples in the category of outcomes in which the horizontal cross sections are circular. This occurs when the axis is changed and the cut goes deep enough to create a cylindrical or circular shape on the new axis. The new axis is then used to form various shapes. All the variables can be used to create this outcome.

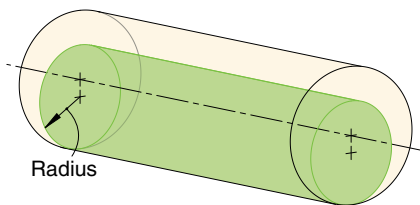
Explore 8 Variations

There are many variations of the axis, including size, shape, and angle. Here are a few of the variations.

3 Symmetry of the curve or angle.

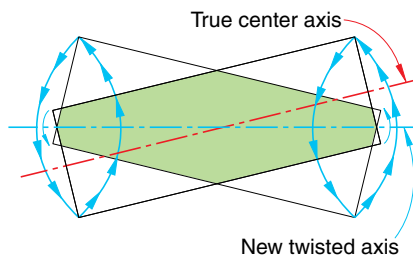
1 The distance of the axes from the center.

The green areas on the drawings below represent the solid wood that is seen as the spindle spins. The area of the spindle that is not a part of the solid wood is the "air wood."

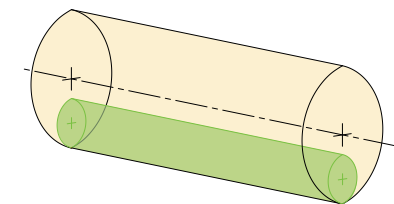


The closer the new axis is to the center axis, the larger the new diameter will be. This makes it harder to create an arc-type turning since a shallow cut will create a cylinder fairly quickly.

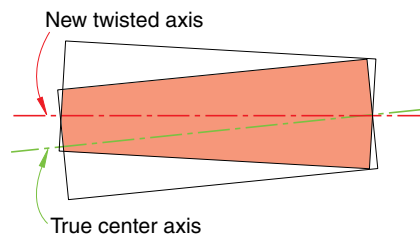
2 Twisting of one end or both ends of a spindle.



The red line represents the true center axis; the blue line is the new twisted axis. The axes in this drawing are both moved in equal and opposite directions from the center axis.



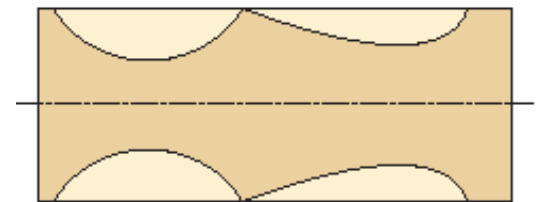
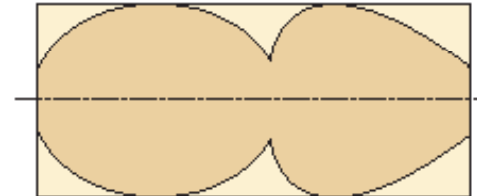
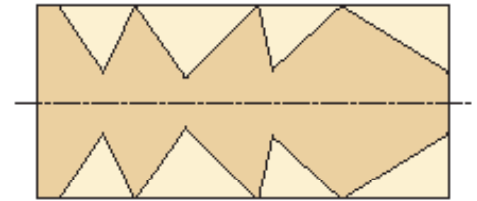
The closer the new axis is to the outside of the spindle, the smaller the diameter will be. Since the cut will be in the air wood, the arc outcome is easier to achieve with the new axis closer to the outside of the spindle.



The green line is the true center axis. The red line is the new axis. In the drawing above, only one end is moved from the true center. The slashed lines in the drawings indicate solid wood seen as the spindle turns on the lathe.



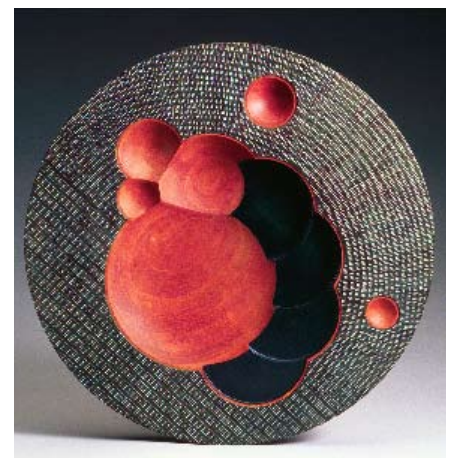
This spindle is a circular type with a twisted axis. On the right end, the axis is in the center. The left end has six axes that are placed in a circle around the center axis. After a cylinder is created on each new axis, a bead is turned. The discs connect each axis.



curves and angles

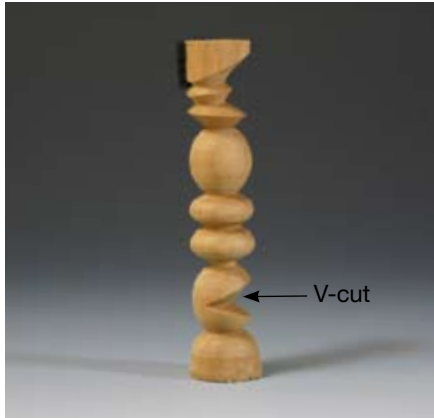
4 The size and orientation of the stock.

The size and orientation of the turning stock makes a big difference in the outcome. Some turnings are of triangular bowls and some are of large sculptural forms using multi-axis methods. There are unlimited design possibilities.



Michael Werner's 11 $\frac{3}{4}$ "-diameter platter "Tosca" platter includes 11 different axes. This piece was a 2006 Niche Award finalist.

5 One type of multi-axis technique superimposed on another type.



This is a twisted multi-axis circular form with a V-cut superimposed on the bottom bead from a parallel axis.

6 A combination of circular and arc-shaped ideas on the same spindle.

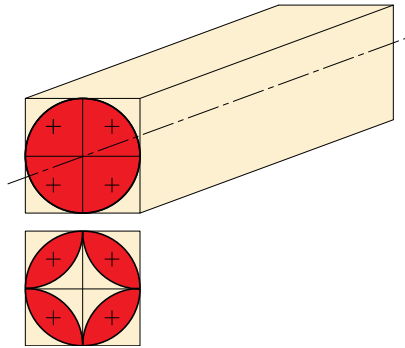


Here's one variation: The bottom bead, *left*, is a circular type and the right profile is an arc shape that is twisted.

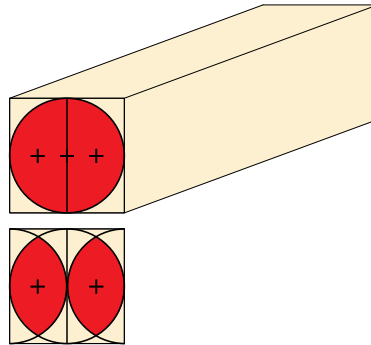


Tom Crabb's three-axis hollow form from wormy maple takes its design cues from a Native American double-neck wedding vessel. 8½×5".

7 Assembling wood to make a split (inside-out) turning.



Four square spindles are turned together and then rotated two to four times. This creates four identical spindles. In the drawing above, two sides were turned.

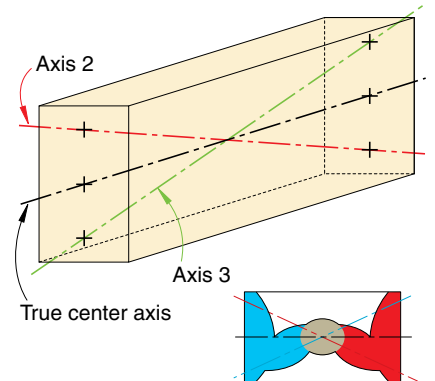


Two rectangular spindles are turned together and then rotated to create a second turning. This creates two identical spindles. The axis of split turnings can either be in the center or twisted. Split turnings create arc-type results.



Mark Sfirri's whimsical baseball bats are signature multi-axis pieces.

8 Starting with a rectangular (instead of square) spindle, allowing an increase in the angles between the axes.



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The Yale University Art Gallery commissioned Mark Sfirri to build a bench with multi-axis work for public seating. Purple heart and ash; 27×68× 20½".