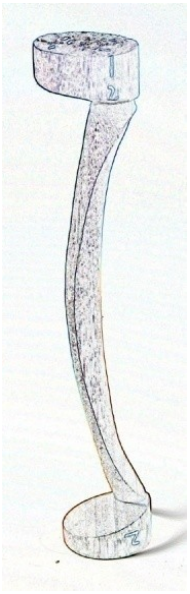
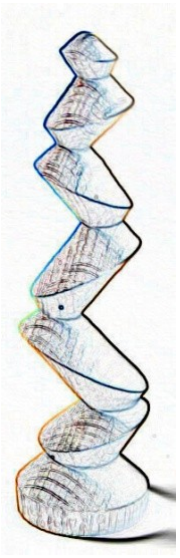
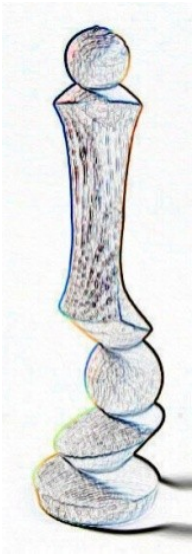


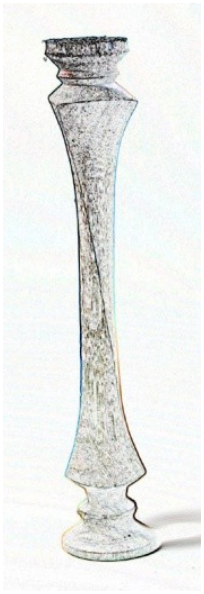
MULTI AXIS TURNING



A NEW TWIST
ON AN OLD TURN



AN EXPLORATION OF THE
FORMS THAT ARE POSSIBLE



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INTRODUCTION

Many turners have randomly switched the axes on a spindle while making whimsical asymmetrical forms. When turning on one axis, it is quite clear what the outcome will be if you turn a bead and a cove on a spindle. When more than one axis is used, keeping up with the axes used, the shape turned and how a certain design was made can get very confusing. This paper lays out a systematic exploration of some of the many forms that are possible to make using multiple axes

Why is a conceptual model important?

-Clarity of thought….Turning on one axis is usually pretty straight forward and predictable. When many axes are used, forms are randomly found by luck and experimentation. A conceptual model provides a systematic way to explore the forms that are possible.

-Paths to explore….Since changing the axis provides us with limitless forms, one must know the limits of the lathe and the wood. In music, the notes must be studied, the limits of the instrument known, and the body must have the skills to produce music. Skill, theory and technique come first; improvisation (jazz) comes later. So it is with wood. This information gives options that one might never know if the axes were randomly changed and cuts were randomly made.

-Creativity….When we think for ourselves, we can then be creative. Rather than copying an idea from another person, this information teaches how to create our own ideas.

Teaching…This information is a teaching model. Rather than saying "this is what I do", we can now say "this is how you think about it. You can now experiment. You can find forms and put ideas together and create". The ability to retrieve the ideas and combine them involves design and aesthetic senses that give the object self-definition and ownership by the artist.

So, this is a conceptual model that shows how to think about multi axis work. This model organizes items that differ (variables) so that one can see how they are related to certain outcomes. This is best understood in the form of a table.

PART 1: Conceptual Model

The key of the model is to first look at what happens when a spindle is turned on one axis. The elements are the beads, coves and the straight Lines that create the profile and the placement of the axis. The results are always circular. This is the composition of the traditional architectural spindle.

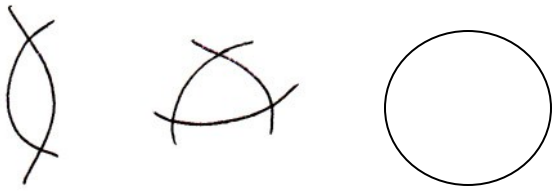
Just as traditional spindles are made by changing the shape on one axis (cutting beads, coves and/or straight lines), multi axis spindles are accomplished by changing the shape on multiple axes.

When the axis is changed from the center axis on a spindle, there are ONLY TWO possible results: either the spindle is cut deep enough to form a new cylinder or circular profile or it is cut less deep, thus creating an arc profile on the wood. This is the most critical observation and is explained in detail next.

The Results (Outcomes)

The basic results (the final product) depend on the things that have been done to the wood (cause and effect). When turning a multi-axis spindle, there are only two basic and stunning types of results that occur.

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 new cylinder. Each of these outcomes can occur when using parallel or twisted axes and any profile



The 2 drawings on the left (above) are horizontal cross-sections that show: arcs, with 2 and 3 axes. The circle represents a cylinder.

Arc Type

Circular Type

The variables

The variables can be applied to either type of outcome to create millions of very different results. The variables are the placement of the axes and the profile.

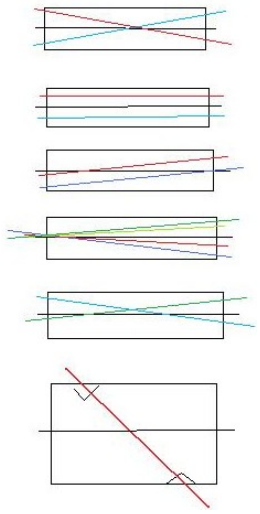
1) Placement of the axes.

Either or both ends of the spindle can be moved from the center axis to a different axis. The distance and direction the new axes are placed with relationship to the center axis is one major variable inherent in multi-axis turning.

1) The axis is considered parallel when each end is moved the same distance and direction from the center axis. Axes can also be parallel to each other and can cross (transverse) the true center axis.

2) The axis is considered twisted when each end is moved in different directions and distances from the center axis so that the new axis crosses the true center axis or each other at some point.

2.



Twisted axes

Parallel axes

Twisted axes and parallel to each other

Twisted from one axis on left

Twisted axes, random placement

Extreme axes

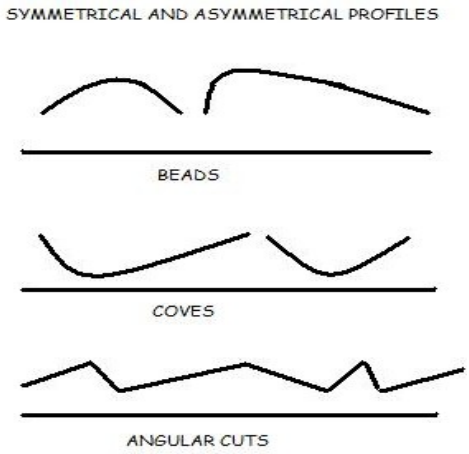
The drawings above show only some of many ways to move the axes. These axes can be in the same plane or in different planes.

There are limitless ways to manipulate the axes.

2) The profile

The profile consists of the curve, straight line, angular cut and all the combinations off these elements

On architectural spindles, coves, beads, or straight lines create a shape. This is also true with multi-axis spindles



More ideas about these two major variables are presented in a later section of this paper)

This table can be used to organize these concepts and to discover combinations that you may have never thought about (There are areas of the table that had voids when experimenting).

OUTCOMES:

VARIABLES:	ARC TPYE	CIRCULAR TYPE
	1	3
Parallel Axes		
straight line	1	7
curved shape	2	8
angular shape	3	9
	2	4
Twisted Axes		
straight line	4	10
curved shape	5	11
angular shape	6	12

The spindles in this photo are arc type outcomes. This means that an arc was cut on the new axis. They all have parallel axes.

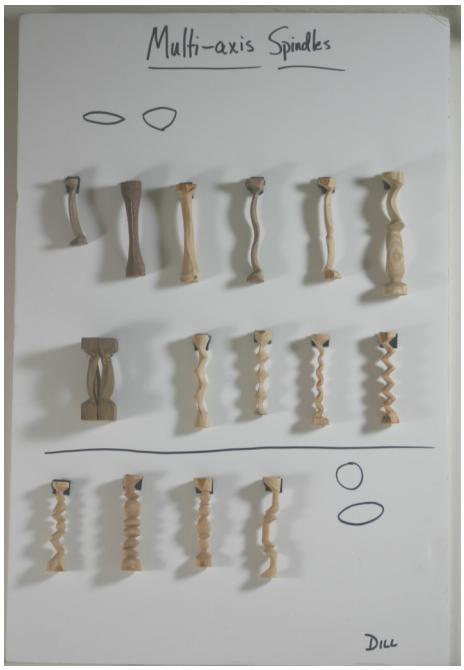
Various Arc type outcomes

There are four quadrants in this table. Quadrant 1 represents parallel axes with profile variables used to make arc type outcomes, and so on. The variables listed here are the major ones. There are more variations on these variables that are discussed later.

The spindles in this photo are circular type outcomes. This means that a cylinder was created on the new axis. The spindle on the right was made with parallel axes; the rest have twisted axes.

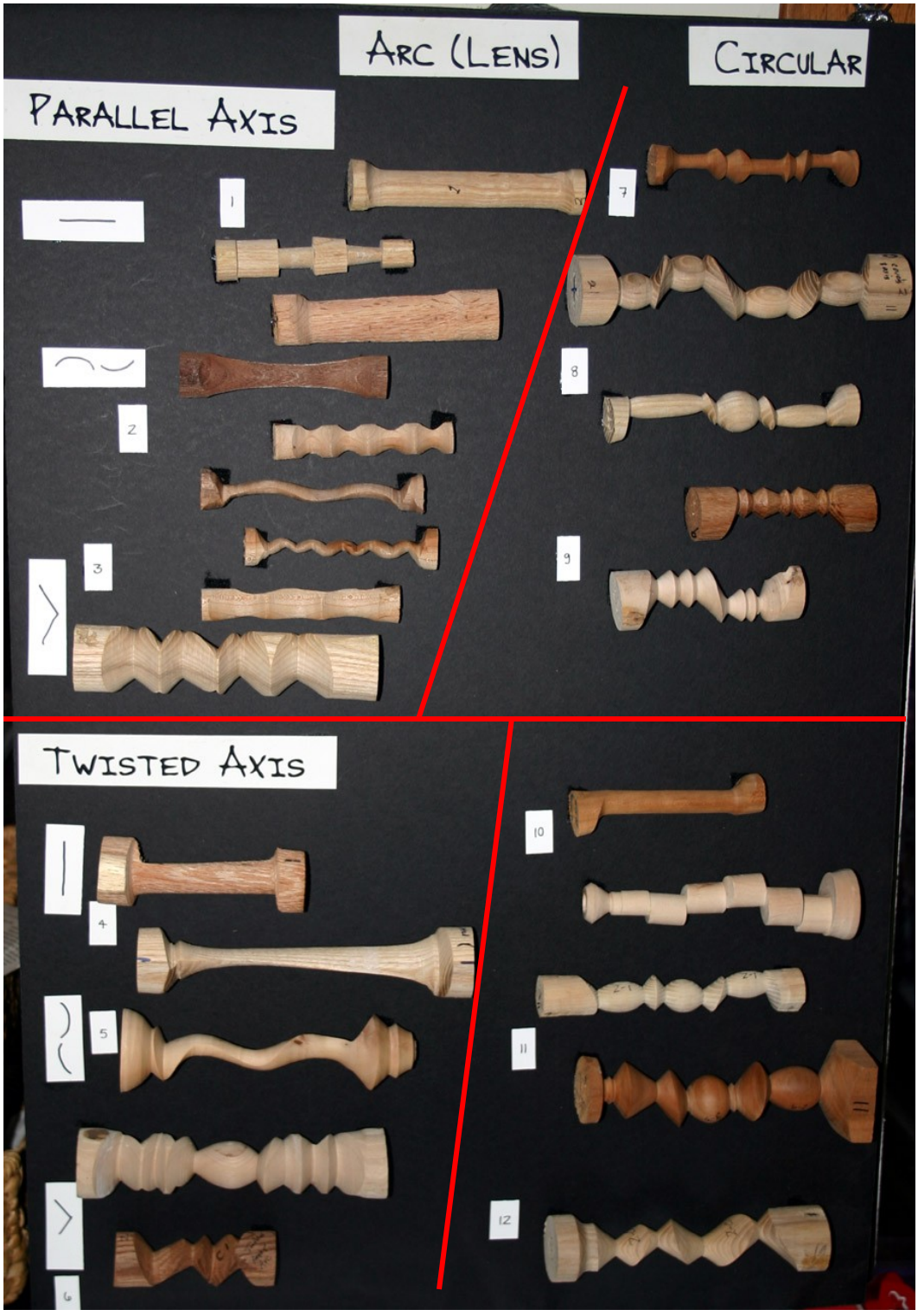
Various Circular type outcomes

THE EVOLUTION OF THE BOARDS



Above: left, the first board I made to categorize the spindles, 9/29/06; middle, more experimenting with arc profiles, 11/06; right, more arc profiles, 12/07

Above: left , circular profiles, 11/06; right, more circular profiles, 10/07.



Teaching board condensed into one board,10/08

The red lines show the quadrants

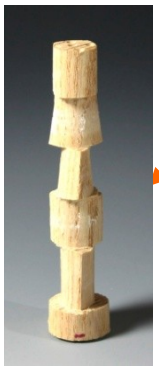
This table is a way to organize the types of outcomes. The photo is a development and teaching board that is based on the table (p. 3)

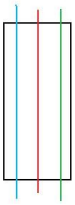
QUADRANT#1

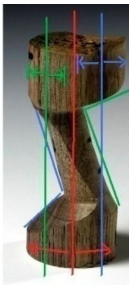
ARC TYPE

PARALLEL AXES

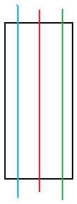
#1 STRAIGHT LINE PROFILE





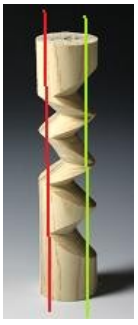


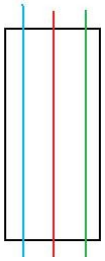
#2 CURVED PROFILE



#

3 ANGULAR PROFILE



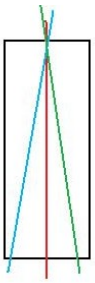


QUADRANT 2

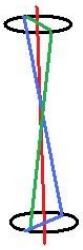
ARC TYPE

TWISTED AXES

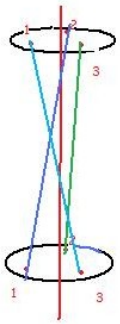
#4 STRAIGHT LINE PROFILE



#5 CURVED PROFILE

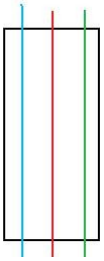


90 DEGREE
TWIST



120 DEGREE
TWIST

#6 ANGULAR PROFILE

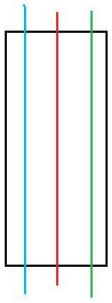


QUADRANT#3

CIRCULAR TYPE

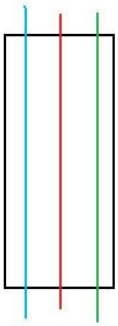
PARALLEL AXES

#7 LINE PROFILE


#8 CURVE PROFILE


#9 ANGULAR PROFILE

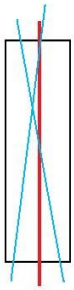



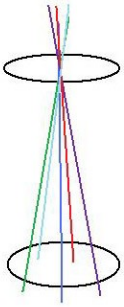
QUADRANT#4

CIRCULAR TYPE

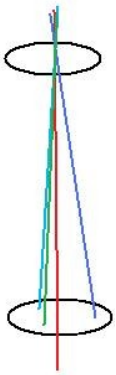
TWISTED AXES

#10 LINE PROFILE

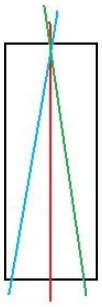



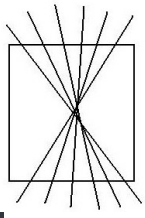


#11 CURVE PROFILE

12 ANGULAR PROFILE

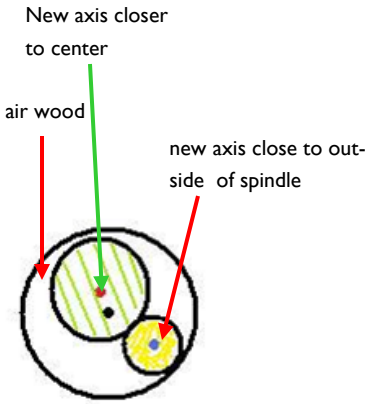


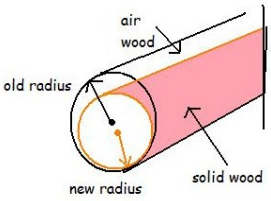
PART 111

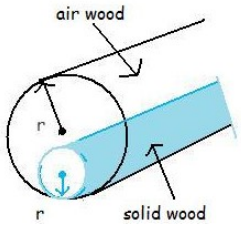
There are many variations in both the variables and the outcomes, including size, shape, and angle. Here are a few of them.

1 The distance of the axes from the true center axis

The closer the new axis is to the center of the spindle, the larger the solid wood is, And conversely, the closer the new axis is to the outside of the spindle, the smaller the solid wood is. When the solid wood is large, a circular outcome is easier to create. When the solid wood is small, it is easier to create an arc type outcome.



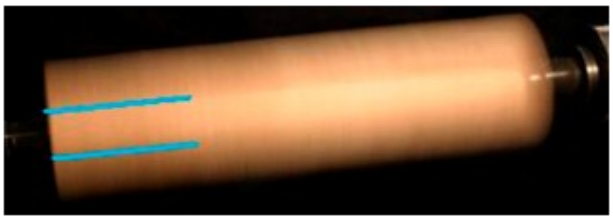


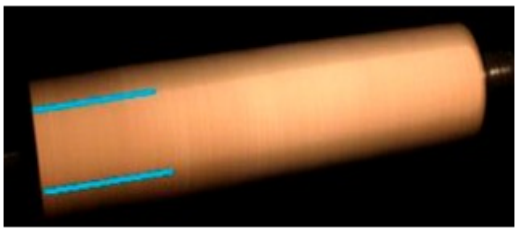


Drawing X

End view of axis placement. Black dot is center axis; yellow area is solid wood and blue dot is new axis close to outside of spindle. Green area is solid wood with red dot being the new axis closer to the center of spindle.

The light blue lines represent the solid wood The new axis is closer to the outside of the spindle making the solid wood small in diameter.

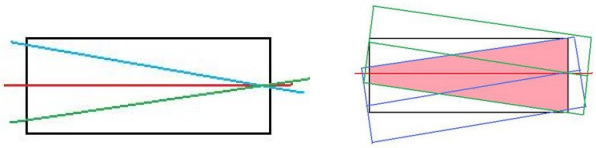


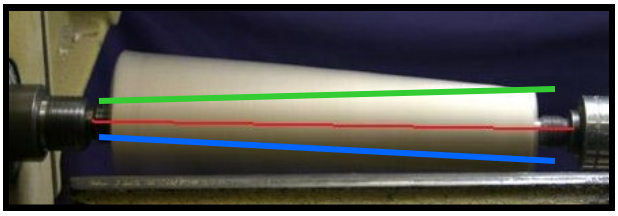


Here the new axis is closer to the center of the spindle, see green arrow on drawing X above

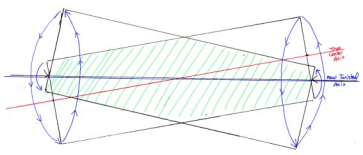
In the images below, only the left end is moved from the true center. Note that the left axis is close to the outside of the spindle. (See drawing below)

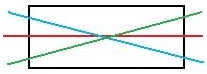
The red center line is the new twisted axis. The right end has more solid wood and can make a circular result; the left end has more "air" wood and can easily result in arc type forms.

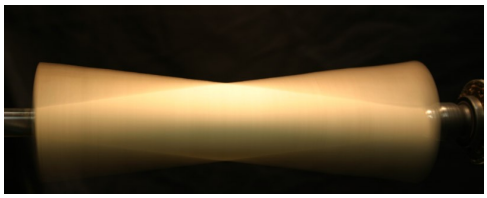




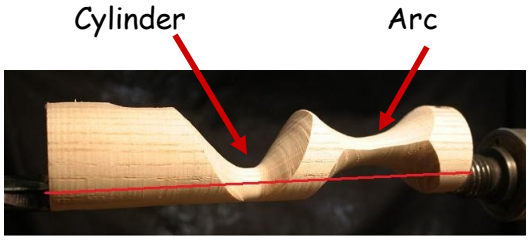
In the images below, the axes are on opposite sides of the center axis creating a twisted axis.

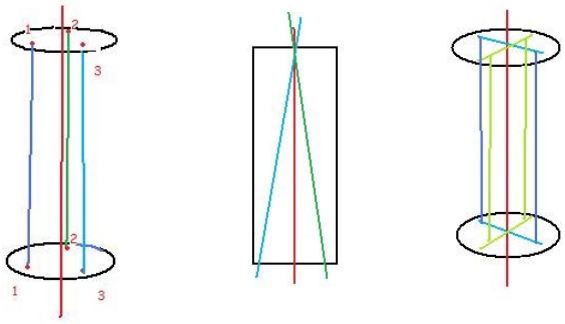






Another photo (below) shows a cylinder on which the axis is closer to the outside of the spindle. Notice how deep the cut must be to create a cylinder or circular outcome. (left side) When the cut is shallow (right end) an arc is formed.





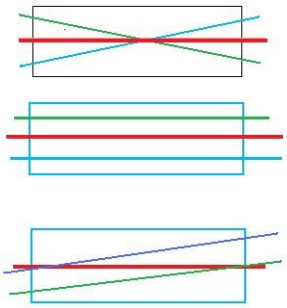
The axis can be moved on one or both ends.

The axes can all be in the same plane or in different planes. The drawing above on the left represents 3 axes which are not all in the same plane. The drawing on the right represents 4 axes which are in planes that are 90 degrees to each other

2 The many variables of axis placement

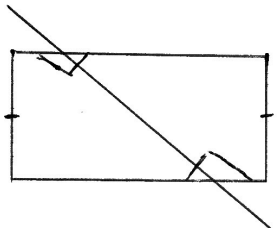
Axes can be parallel to each other. These parallel axes can also be parallel to the true center axis or they can be non parallel to the true center axis (or transversal).

Axes can also be non parallel (transversal) or twisted in relationship to each other and in relationship to the true center axis.

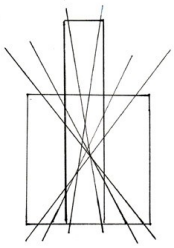


From top: twisted axes; parallel axes; parallel to each other and transversal to the center axis.

The axes can be extreme by using the sides of the wood rather than the ends. (below)



The size and orientation of the wood is discussed later in this paper. However, these images (below) show how the height and width of the wood can create a very different effect, even when the same axis pattern is used.



The combinations of these ideas are limitless.

3-Symmetry of the curve or angle

The profile consists of lines angles and curves. These elements can be either symmetrical or non-symmetrical. The photos below are examples of both symmetrical and non-symmetrical forms

The goblet on the left has symmetrical curves. The goblet on the right has non symmetrical curves.

An interesting note is that arc type forms can have shapes opposite or alternating from each other; for instance, coves can be opposite or alternating, while circular results, by definition, have circular sides. In the above photos, from left to right: opposite coves; alternating beads; and circular forms.

4 -Connecting one element to another.

There are many ways to connect the elements of a multi axis spindle. A sphere or a v-cut can be turned on the central axis before the axes are changed the photo on the right demonstrates this. Creating discs, or a golf club like shape are some, but not all, of many other options

In photo on left, the red arrows point to v cuts that were mad before the axes were changed.

5 - Variations on the same spindle:

All of these ideas can be mixed and matched. In this photo, the bottom and top beads are circular types and the middle profile is an arc shape. The axes are twisted.

-

An idea superimposed on another element.

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

6-The size of the stock.

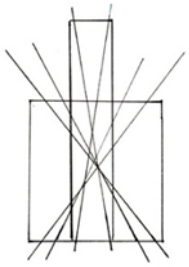
Many makers now and in the past have created multi axis works that are various sizes of wood. I have been working with long thin spindles when experimenting with what can be done (as seen in the previous photos used for examples).

John Pirson, a Belgium wood turner, uses a block of wood that is about 3-4 inches wide and 4-5 inches long. He then turns v- cuts and uses twisted axes that are in the same line and plane on each end and starts with opposite ends of the lines. He goes to the new axis with each cut making it a circular type outcome.

:

John Pirson's multi axis candle holders (same idea, different dimensions)

6-



This drawing illustrates the angles that can be used with different lengths of wood.

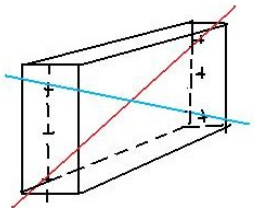
(see above photo)

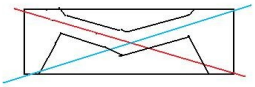
Vessels can be made by starting with another stubby rectangle which is about 3 inches wide and 4 inches long. Arcs made of a bead profile are cut on 3 twisted axes that are 120 degrees from each other on each end.

This creates an arc type outcome. Now they can be hollowed to create vessels.

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

In the photo below with 3 examples, on the left, the beginning of turning with a rectangular blank; the center is an example of having three axes that do not meet as expected; and the right is turning the three axe s that are lined up correctly





Long and slender wood Dutch Foot Legs

Jon Siegel has laid out plans for making dutch foot leg (sometimes called club foot, pad foot, or spoon foot). The lathe has been used for centuries to create projects like this.

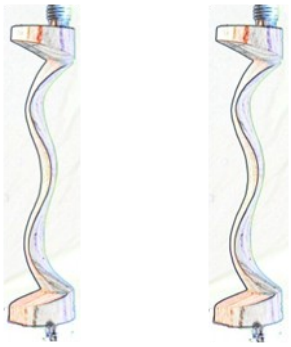
(top-center axis; next-same plane , opposite sides of center axis; next-leg is thinned ; next, center axis to finish foot.)

7-Deciding how to resolve the ends of the spindle

The next decision has to do with design options. Any axis can be used to resolve the spindle, even an axis that was not used on the spindle. This is very important.

The goblets below are just three options used to align the spindle with a base and goblet cup. Notice that the results are very different.

Center twisted parallel (off-center)



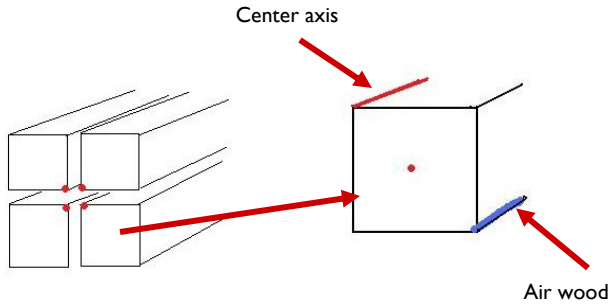
Another example of the use of different axes when finishing a project.

8 Assembling wood to make a split (or inside out) turning

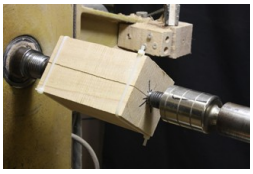
The end product of split turnings are multi axis turnings. This is a method of turning that has been used for centuries. In Europe, square looking pedestals were created by attaching wood to large jigs that could hold the spindles far away from the center axis of the lathe's center. Old therming lathes had swings of up to 6 feet and could produce relatively square looking spindles. (See Mike Darlow's book, Woodturning Methods, Sigi Angerer's article, AAW 98, Ray Hopper's book, multi axis turning) Many turners today are using these ideas to create spindle and face plate turnings that are spectacular. Take a look at Wood Central to see all the work that is being done.

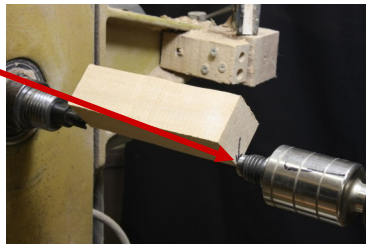
All split turnings, when assembled and then turned on the absolute center axis, result in arc type outcomes with parallel profiles.

The red dots in the drawing on the left shows the axis used to turn the four pieces. On the right: The wood is cut on the opposite side (blue) from the axis used to turn it (red).



This is how it looks if only one piece is put between

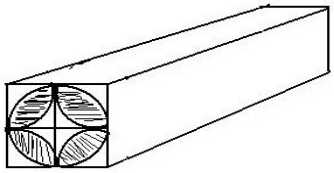




Split turnings are advantageous for a few reasons. Four masterpieces (or four pieces for the fire) can be made at the same time. The technical advantages of turning multiple spindles together as opposed to separately are a) the turning is balanced and b) the tool is cutting more solid wood than air wood.

Split turnings

The square pieces of wood are turned together and then rotated two or more times. This creates identical spindles. In the drawing below, all four sides were turned and then assembled creating an inside out turning.



This was turned in the mid 90's after attending a symposium in Tennessee

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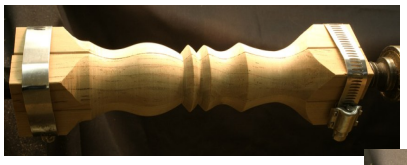

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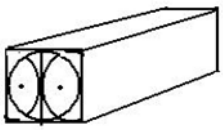
The image in #5 shows a how the axes are numbered and changed for the third turning. Number 6 shows the third turning and #7 shows the 4th turning. Number 8 shows the turnings separated.

The two rectangular spindles below are turned together and then rotated to create a second turning. This creates two identical spindles. The same spindles can be turned between centers using the center axis of each rectangular piece of wood.



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The photos below show the steps in making a split turning. There are many ways to hold the wood together. (1). I use two sided tape and a hose clamp to secure the wood when I am using small pieces of wood.(2). A numbering system must be established to avoid confusion; (3). The first axis when completed (4) The wood has been rotated and the second axis is ready to be cut

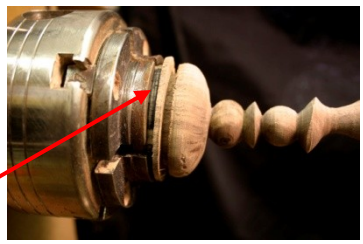
9 Chucks

Turning any of these axes can be done between centers or with eccentric chucks. Some chucks hold the wood on parallel axes and some rotate the wood to create twisted axes.

Many of the delicate turnings done by Jean Francois Escoulen and his students require chucks, since the work is too fragile to turn between centers.

I don't have a chuck and so far have enjoyed working between centers. My multi axis goblets have all been turned from 3 pieces of wood, making the cup, stem and base.

However, playing around with the idea of a chuck, I've found that the tenon can be used to tilt the spindle and create new axes. This is one way to turn a multi axis goblet from one piece of wood.



The arrow points the gap (between the shoulder of the chuck and the bottom of the spindle).

There are many other ways to create split turnings. See Peter Exton's article in Feb. 2010 issue of the American Woodturner.

There are ways to create face plate turnings by creating jigs to place them on while turning.. That is Another article written by another person.

Some of many examples

Here are some images to illustrate some very creative ideas.

The work of Tom Crabb illustrates how he applies multiple axes to hollow forms and bowl forms. Below is one of many of his pieces.

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

Tom Crabb's Ocarina Turned from a maple burl7"HX 3.5' W . Turned on two axes; the first is the sound chamber which was hollowed from the bottom; the air way or stem is the second axis.

Stoney Lamar has made beautiful sculptures by using several axes on large rectangular pieces of wood. In his artist statement, he says "The original development of multiple axis techniques became a way of sculpting

Mark Sfirri and Michael Hosaluk have done wonderful work using multi axis ideas.

SUMMARY

Knowing variables and outcomes is a way to way to organize thoughts when planning a multi axis project. The model presented here is an alternative to total random experimentation. Now, one can experiment using forethought. Many spindles must be turned with many mistakes to find one's own creative forms.

I think many people believe that multi axis turning is way too complicated for them. I encourage folks to play with spindles and these ideas. The results can be very exciting.

The shapes made by switching the axes are owned by no one. However, the ways the shapes are combined are the creative designs of the maker.

This paper contains many ideas about ways to shape wood using multiple axes. Many turners for centuries have worked on multiple axes. This conceptual model is a way to understand how these objects were made and gives the reader a way to create rather than copy.

Of course, there are more ideas that are great jumping off places for one's creative bent. Look at the web like wood central, go to workshops, read some great books and articles that have been written about this and, last but not least, spend hours of fun experimentation. You will find that the work is both frustrating and rewarding. However, the ideas are endless.

Barbara Dill lives near Richmond, Virginia and has been turning wood since 1990. She teaches locally and regionally. Visit her web site at www.barbaradill.com