Introduction to Off-Center Turning

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Basic Principles of Off-Center Turning

In **spindle turning** we are all familiar with the center axis of a piece of wood. We find the center of a piece, mark each end, and turn a cylinder along the center axis.

What would happen if we changed the axis? It depends.

There are two types of axes in off-center spindle turning: parallel and non-parallel, henceforth known as **twisted**.

Sample axes:

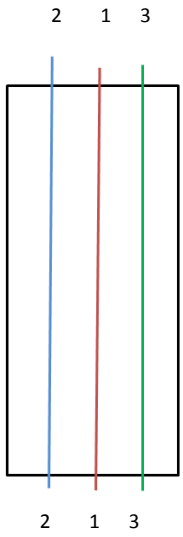
Parallel Axes

Red line is the center.

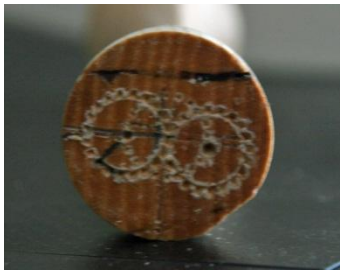
The **blue** and **green** lines are parallel to the center axis.

Note that the axes are numbered exactly the same on both sides.

Sequence of turning:
1 to 1
2 to 2, etc.

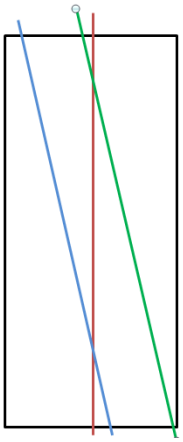


2 parallel axes.

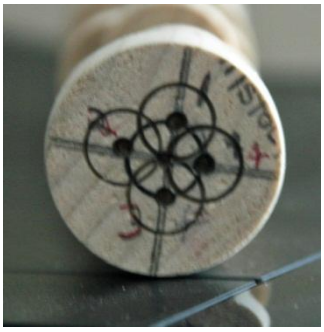


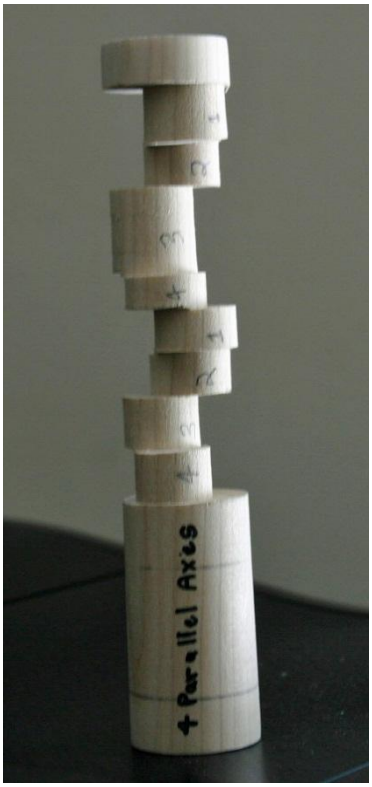
An axis is considered ***PARALLEL*** when each end is moved the ***same distance*** and ***direction*** from the **center** axis.

Axes can also be considered parallel even though they cross the center axis.

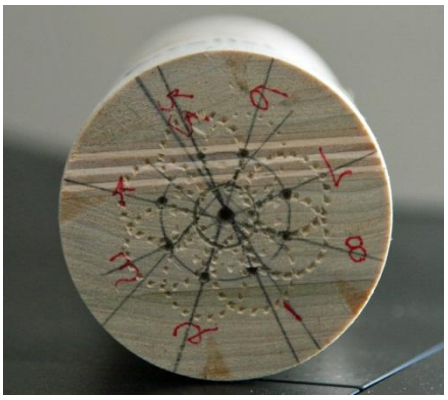


4 parallel axes





8 parallel axes



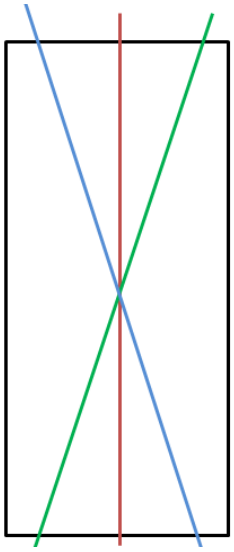
Twisted Axes

Red line is the center.

The **blue** and **green** lines intersect the center axis.

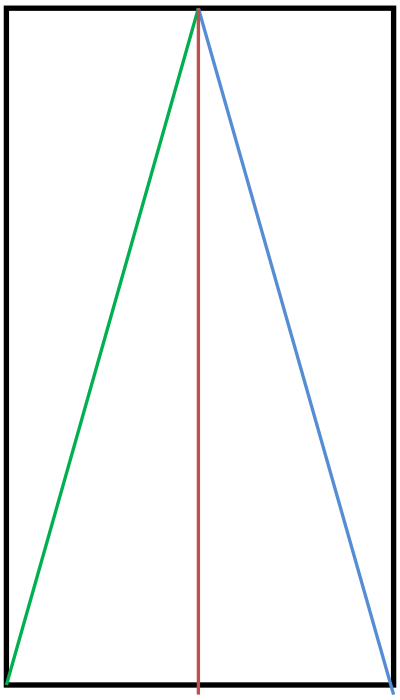
Note that the axes are numbered exactly the same on both sides.

The twist comes in varying the sequence:
Examples:
2 to 3
1 to 3
2 to 1, etc.

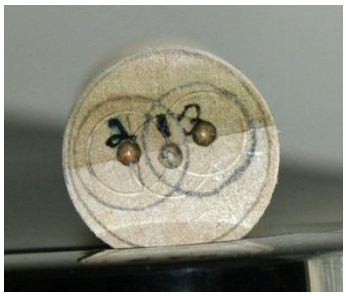


An axis is considered ***twisted*** when both ends are moved in **different directions** and **distance** from the center axis so that the new axis intersects the center axis.

This can also be considered a twisted axes:



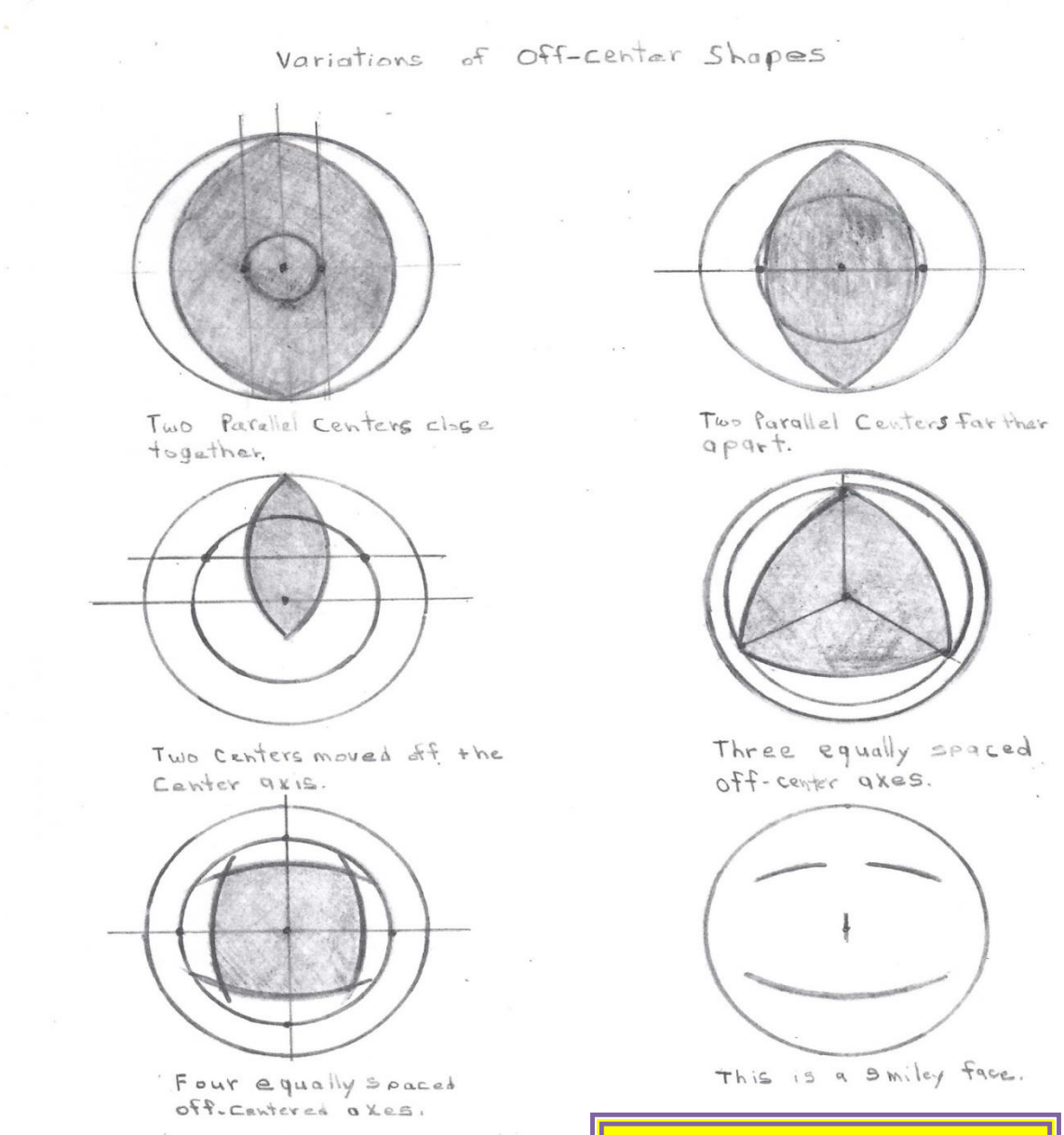
Three twisted axes

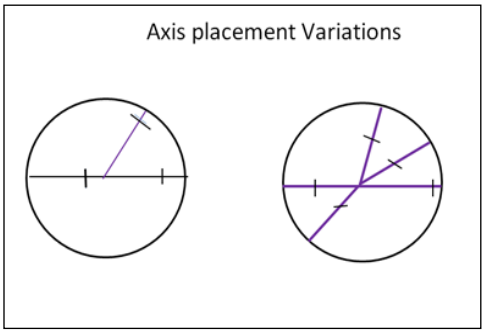


Note that last two photos look radically different, even though they are both three twisted axes.

MUCH DEPENDS ON THE PLACEMENT OF THE AXES AND THE TURNING SEQUENCE.

VARIATIONS





There is no limit to the number of axes, and no limit to their placement.

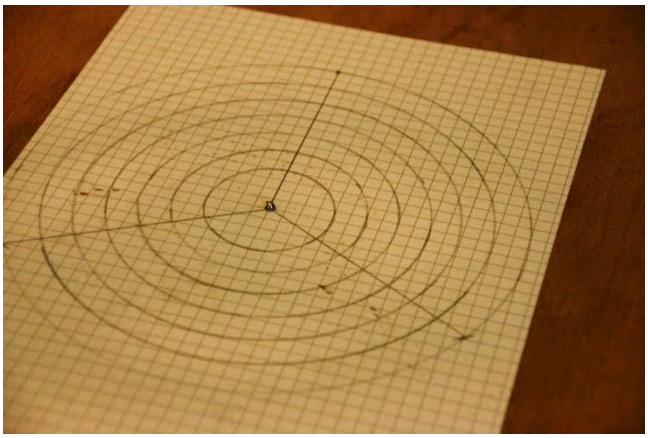
However, make sure the numbering or lettering system matches on each side of the workpiece.

Drinking Cup w/ a Twist

Turn to a cylinder.
Make sure it is even all the way across.

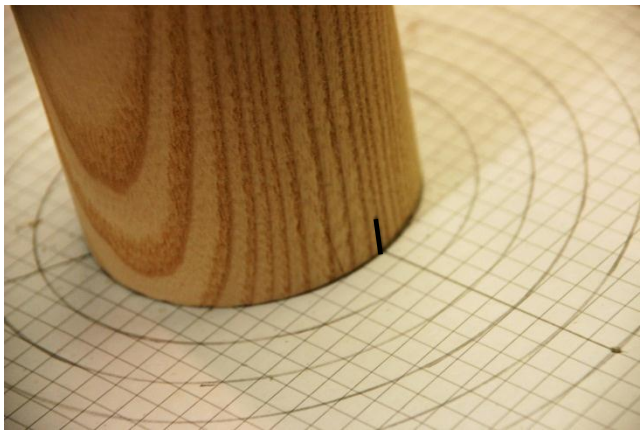
Tired of repeatedly drawing 120 degree angles on wood, I made a template by drawing concentric circles every ½". I then measured the 120 angles and pasted the paper to a piece of scrap wood. I then inserted a small screw from the back into the center.

Another method using a compass is explained later.



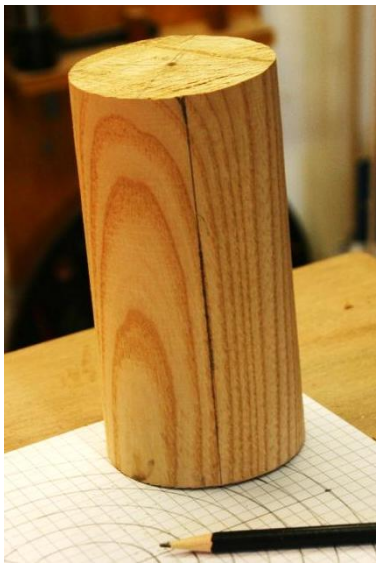
Since there is already a centered hole on each end of the cylinder, place the center hole on top of the screw.

On one side, mark all 120 degree increments.

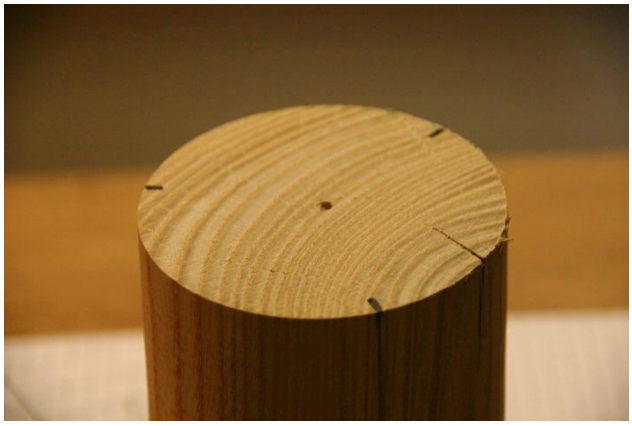


Using a square, draw a line across the cylinder to the other end.

Do the same for the other two marks.

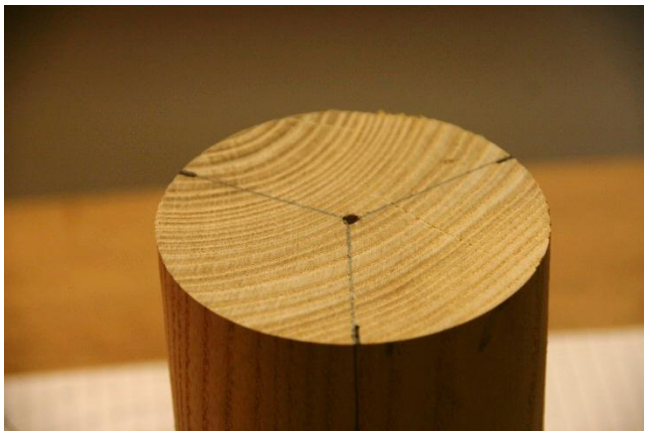


Mark the top of **each side** of the cylinder.



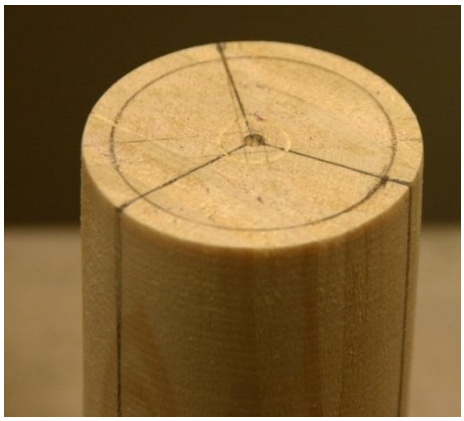
Draw lines from the edges to the center.

Do this on **both** sides.



Draw a circle that is 1/4” from the edge.
Do this on **both** sides.

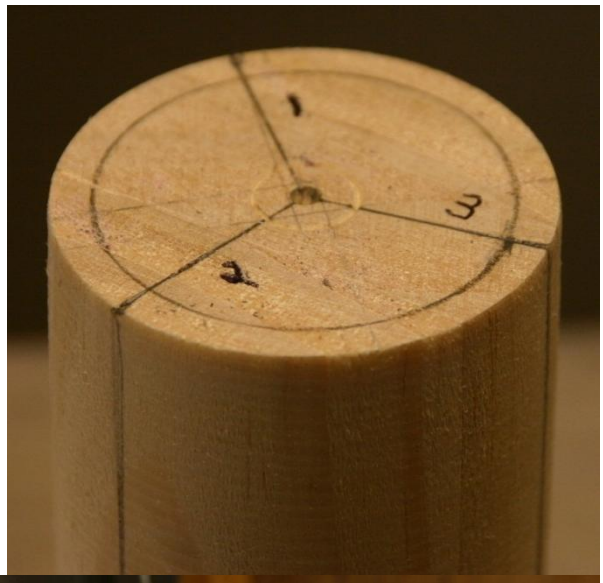
This marks the **depth of the tenons** you will turn later.



Number the lines on one side **counter clockwise**. This will give the cup a <u>left-handed</u> twist.

<u>Match</u> the numbers on the other end; that is, #1 will be <u>exactly</u> opposite #1, etc.

(A clockwise numbering will give you a <u>right-handed twist</u>.)



Place the cylinder back on the lathe between centers and mark off ¼” from each end.

Turn the tenon down to the first circle that is 1/4” from the edge.

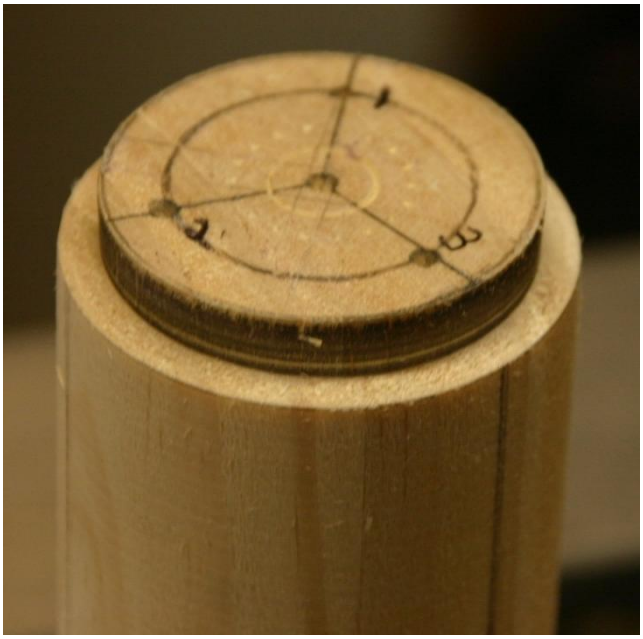
Darken the tenons with a pencil or marker.

The darkened tenons will become a reference point while turning.

Remove the cylinder from the lathe and draw a circle ¼” from the edge of the tenon.

Use an awl to punch holes where the circle intersects the 120 degree lines.

Do the same for the other side.



Label a bottom and a top.

You are now ready to begin turning the cup.

Caution:

- Make sure that the cylinder is ***ABSOLUTELY*** secure during the turning process. Check **frequently.**
- Set your lathe speed to what is comfortable for **you**.
- However, the faster the speed, the smoother the cut.
- Understand that you can hand-sand the project when you are ***finished***. This is why God created sandpaper.

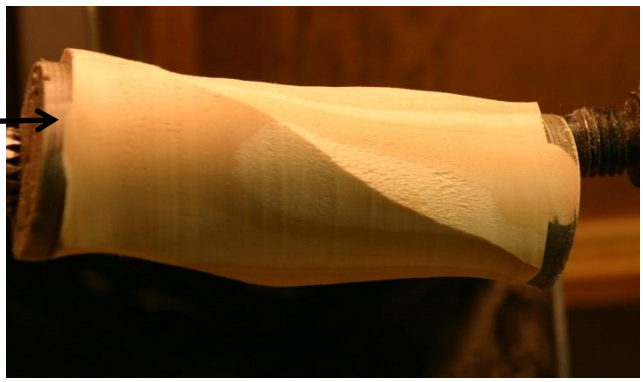
Turning sequence:

Headstock	Tailstock
3	1
1	2
2	3

Using whatever tool you feel comfortable with, turn **each end** until you reach the pencil-shaded tenon.

Start from the center and take light cuts. Stop frequently to check the tenons.

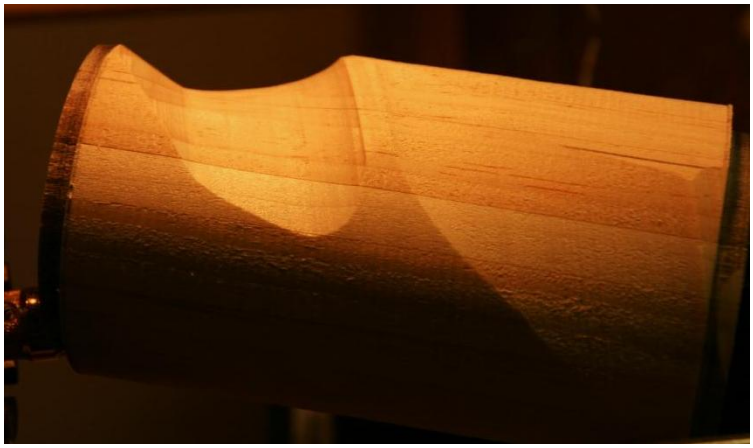
The center should have a slight cove.
The result of turning from axes 1 and 3.
Note that the turning lightly touched the penciled tenons.



Then, using a caliper, measure about a third of the way from the bottom.

Mark it with a dark pencil.

Form a cove. This will become the “handle.”



Blend the top portion with the cove.

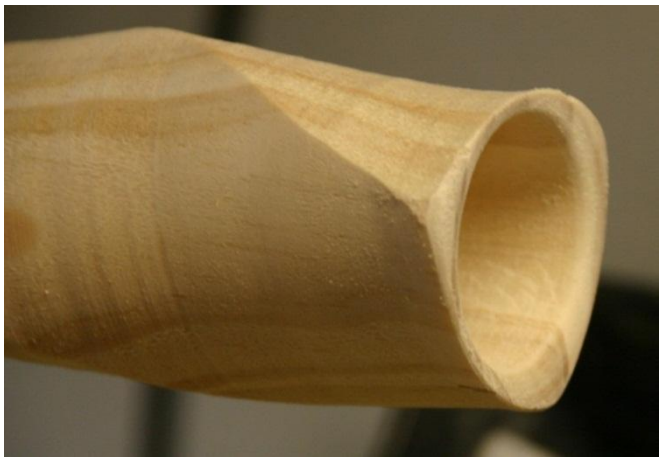
Use a different set of calipers to measure the depth of the **finished** cove.

Go through the next sequence and repeat the above. **The key is to match the depth of each cove.**

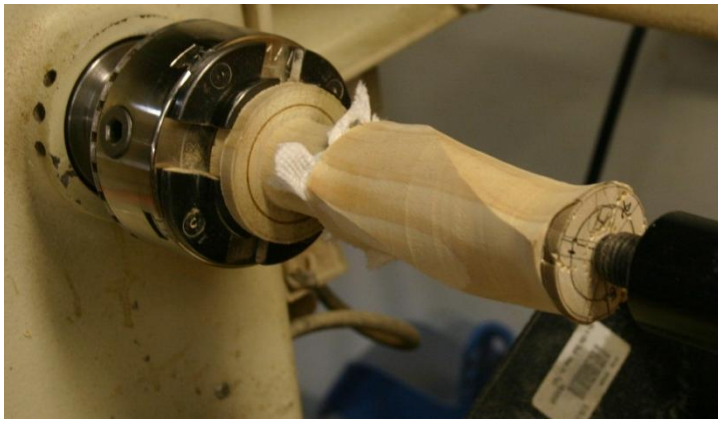
When you are finished turning all three axes, remove the cylinder and place it on a chuck.

Drill a hole to (whatever) depth.

Trim the top.



Reverse the cylinder and place it on a jam chuck.

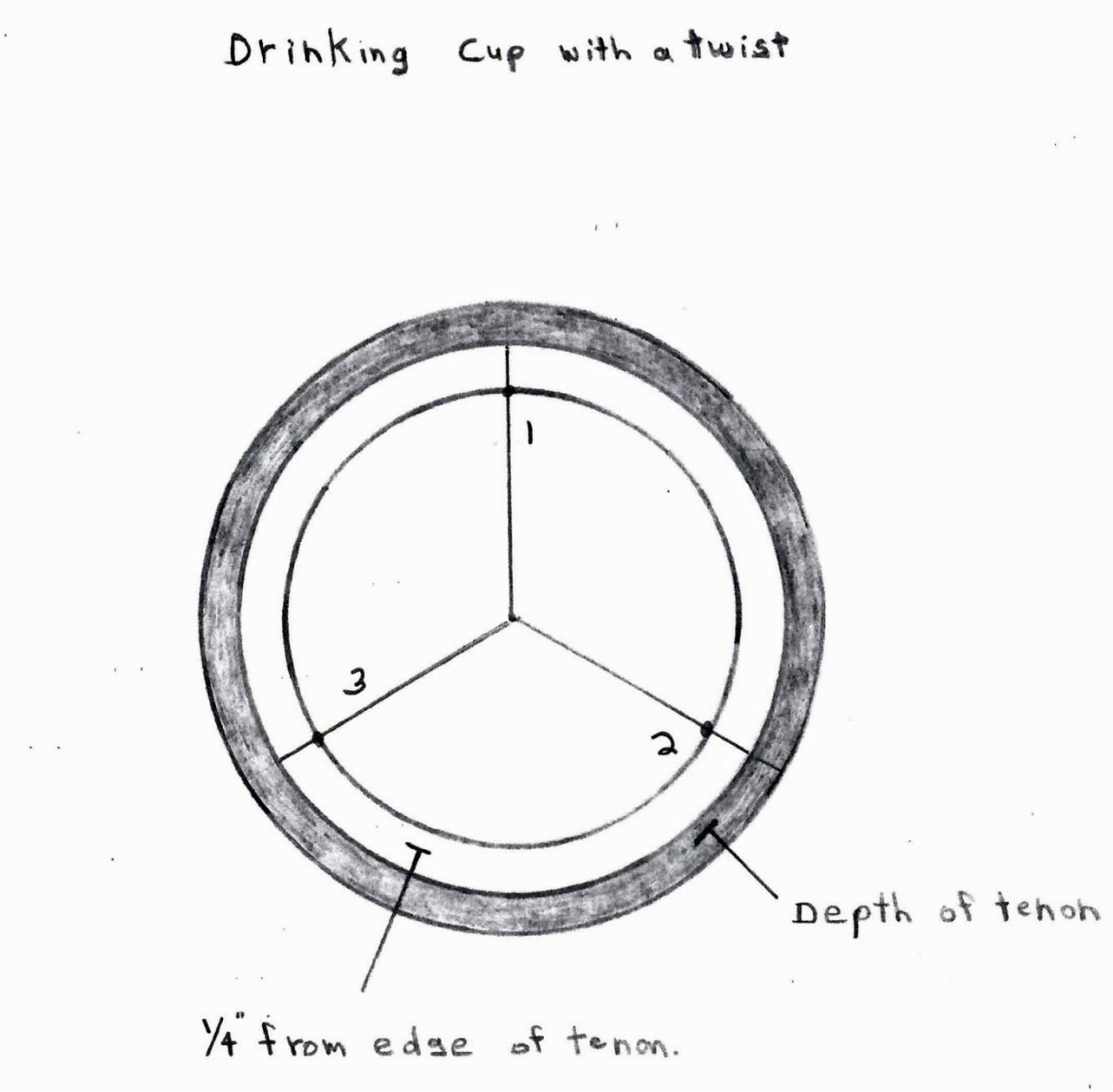


Trim and sand the bottom.

Sand the entire cup to 220 grit or greater.

Apply a finish.

Diagram for Drinking Cup

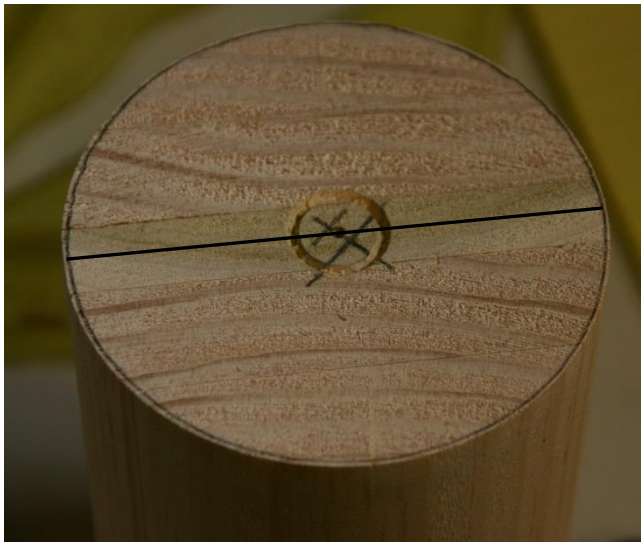


Alternative method for dividing a circle into 120 degree segments.

Using a compass, draw a circle close to the rim of the piece.

Do not change the setting on the compass.

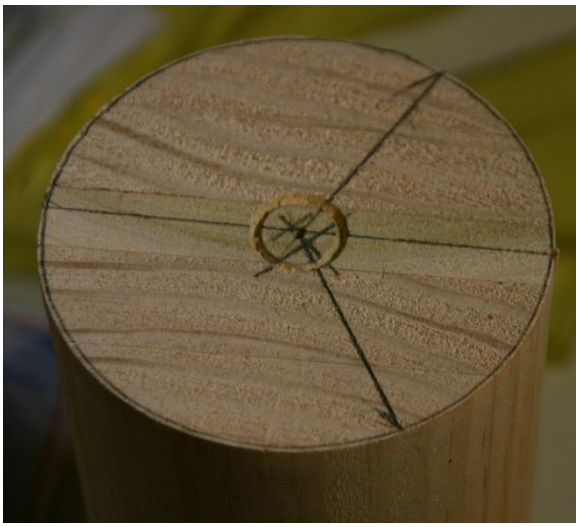
Draw a diameter line.



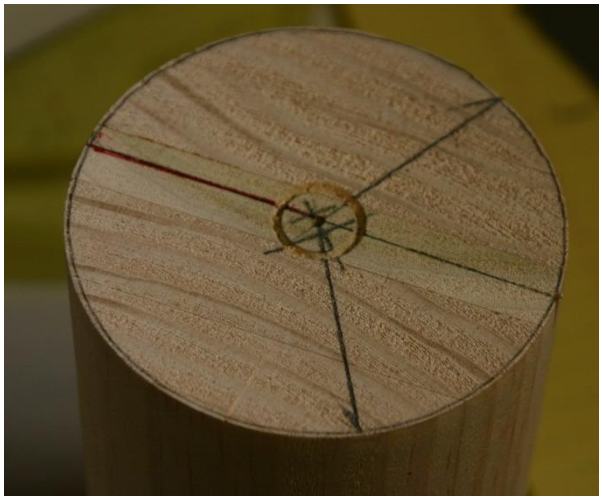
Place the needle of the compass where the diameter line intersects the outer circle and …

… draw two arcs: one above and one below the diameter line.

Draw lines from the arcs to the center hole.



The third line (in red) then marks the circle in 120 degree segments.



3-Axes Off-Center Turning

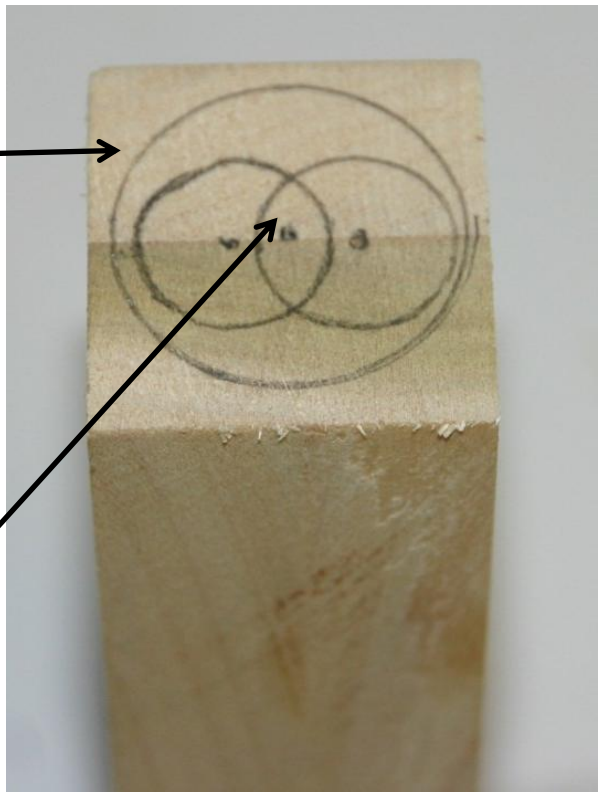
This is only **ONE** method of placing the axes.
Feel free to try others. There are countless variations that you can experiment with.

Axis #1: Center hole. Note a circle was drawn close to the edge.

Axes #2 and #3: Each was positioned 1/4" on either side of the center axis.

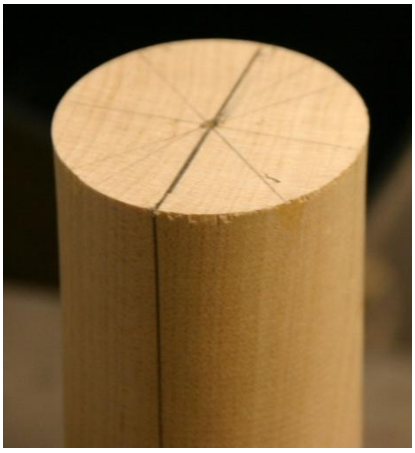
Axes can be placed **ANYWHERE** inside the outer circle. Experiment, but document the sequence you use to see which outcomes you like, or to duplicate with a second turning.

When tuning off-center, you will turn "air" and it will be difficult to determine how much wood you will need to leave without the turning breaking. Additional circles were drawn **INSIDE** the outer circle. The space between the interconnecting inner circles will give you an idea as to how far to" push the envelope."

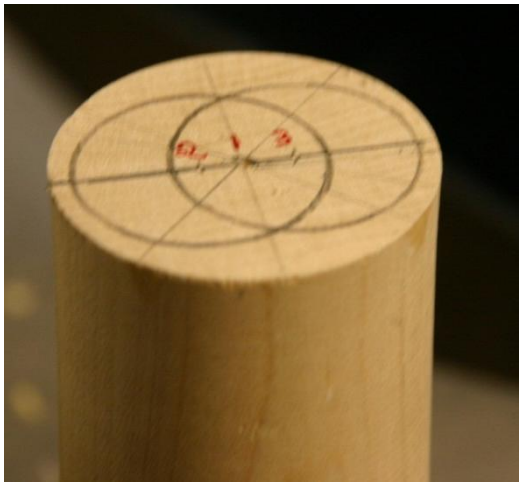


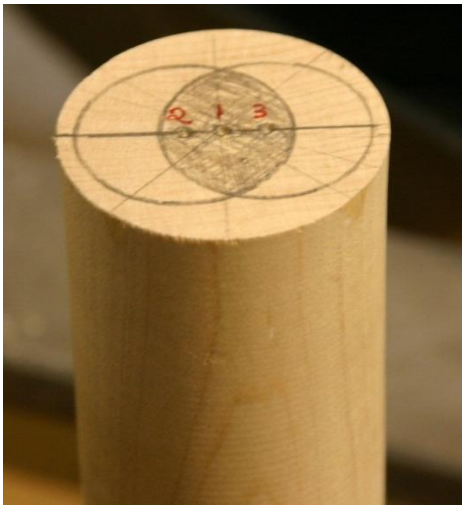
It is extremely important to match the axes on the opposite side of the turning. The numbers should match end-for-end.

Using a square, draw lines to the other side to mark the axes, and repeat the above process of drawing the circles.



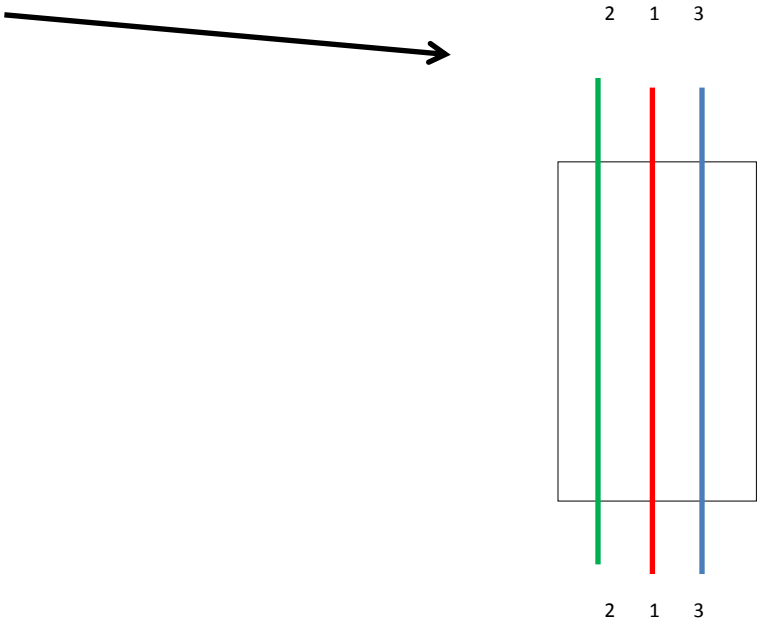
Use an awl to punch holes and number them as you see here.





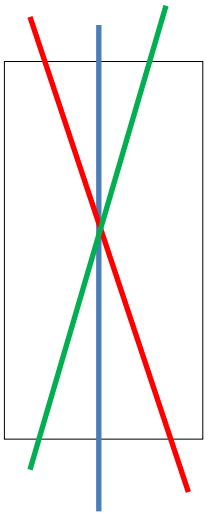
Again, make sure the numbers match on both sides

Matched parallel axes.



Or, the center axis can be crossed in any sequence that you choose.

The top photo on page 20 of the completed project followed this sequence:



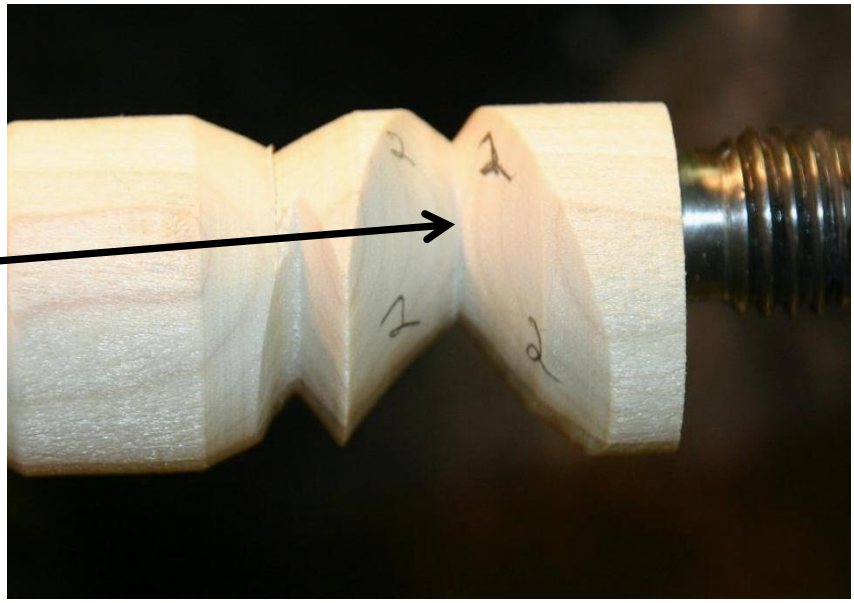
2-----2
3-----3
1-----3
1-----2
3-----2
3-----1

Note: you are not limited to three axes.

Recommended:

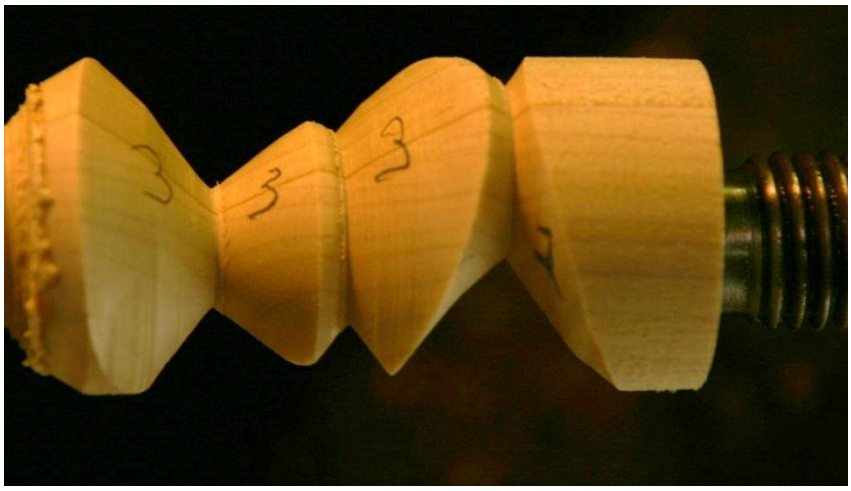
- ☞ Use a very sharp spindle gouge with a secondary bevel.
- ☞ Make sure the holes for the axes are not too close to the edge of the workpiece. Too close and it may come off the lathe fast.
- ☞ "V" cuts and coves work best.
- ☞ Turning speed: 2000-3000 rpm.
- ☞ Carefully ease the tool into the turning
- ☞ Stop frequently to check your work.

2-----2



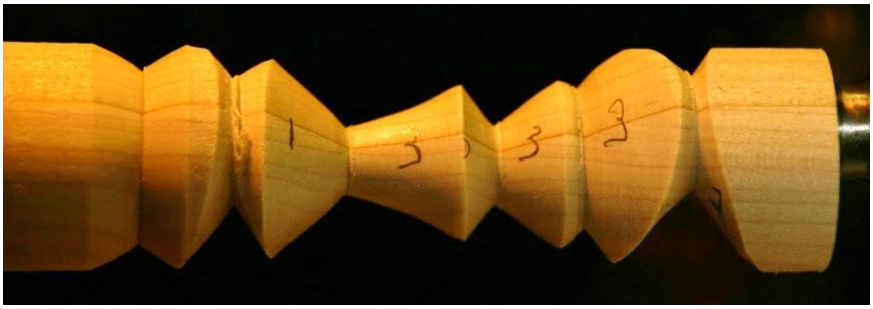
Note that the size of the center of this phase of turning closely matches the space between the intersecting circles seen on page 1. Turning any deeper could make the spindle break, particularly at high turning speeds.

3-----3

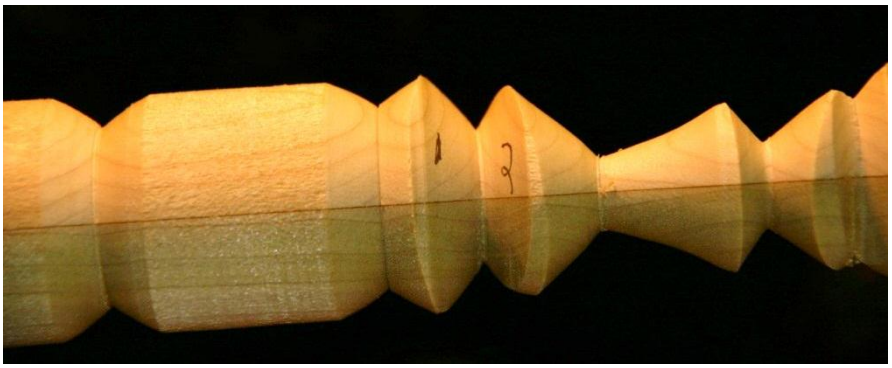


Variations on the #3 axis.

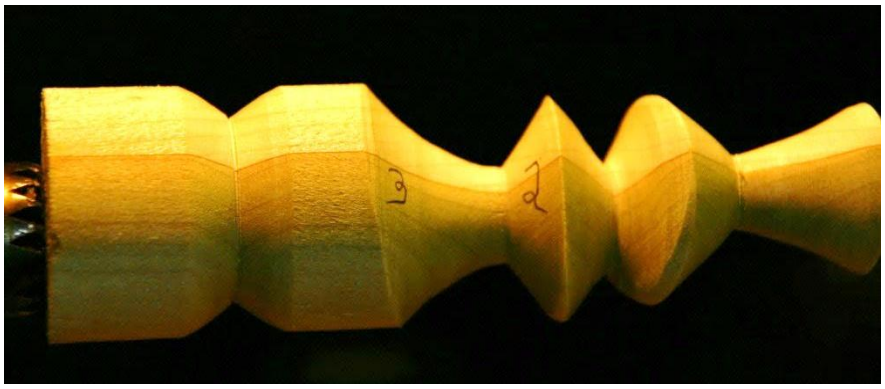
1-----3



1-----2



3-----2



3-----1

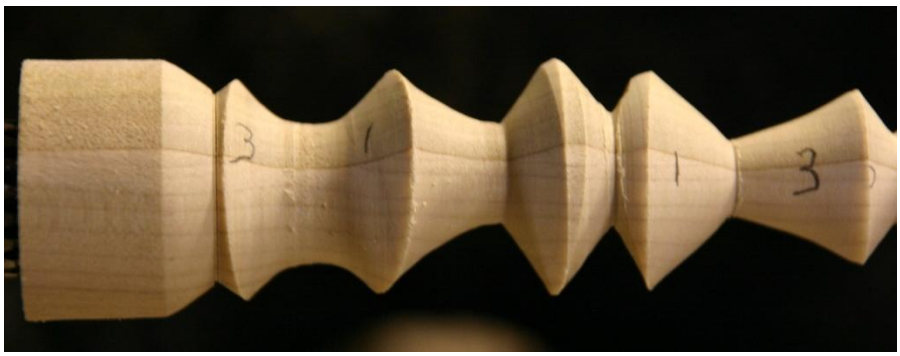
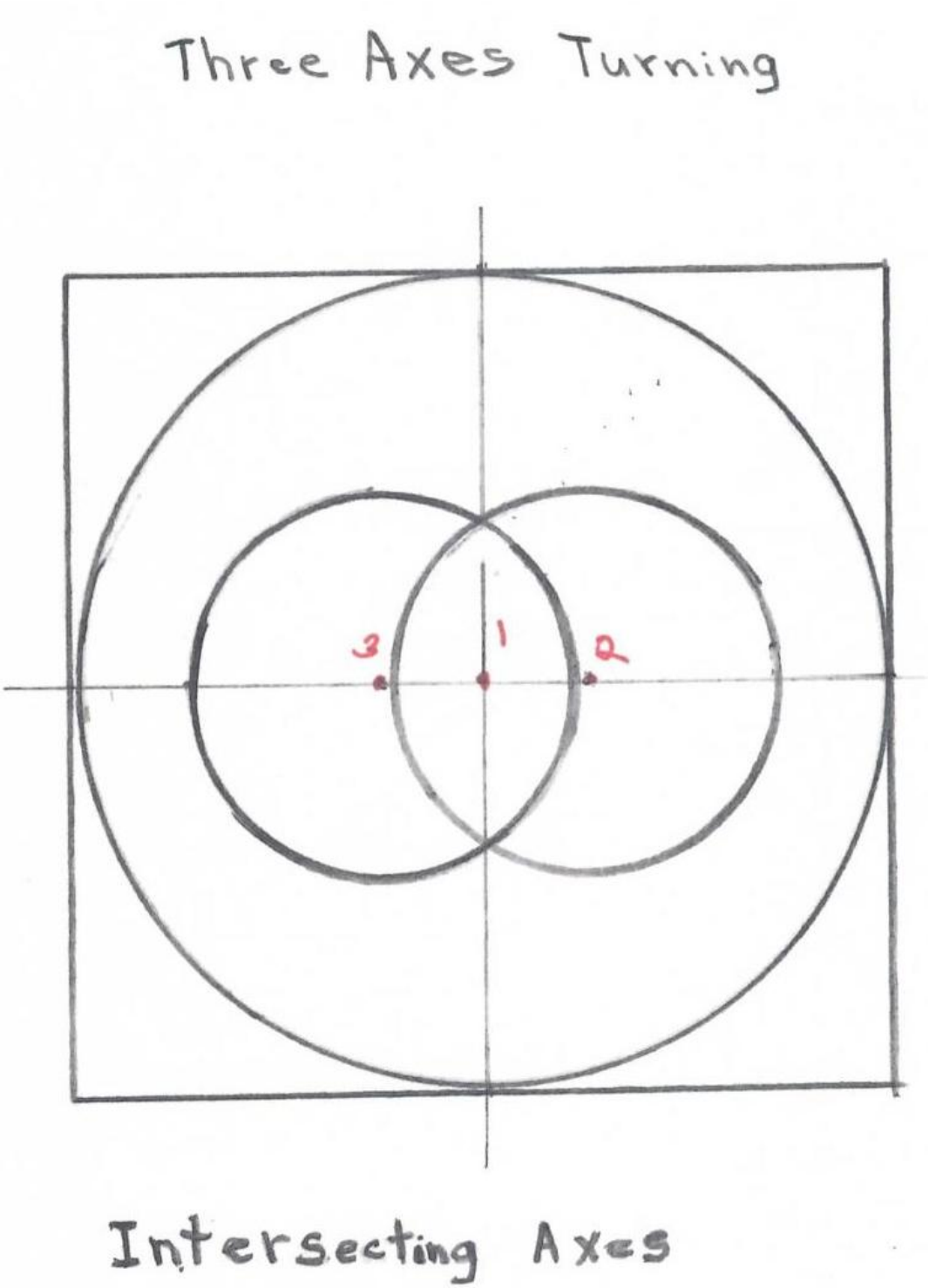
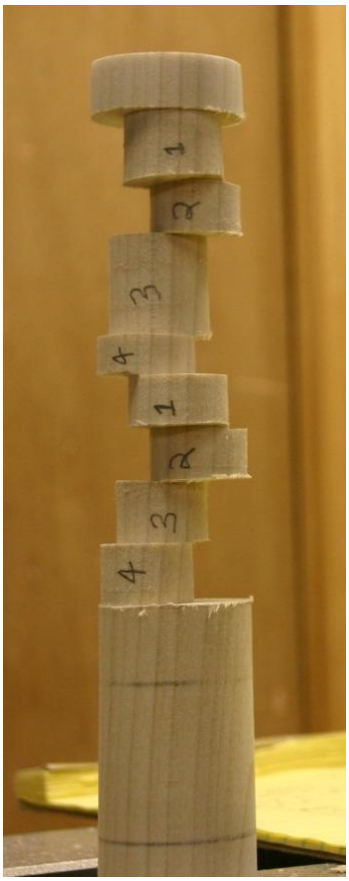


Diagram for Three-Axis Off-Center Turning



Parallel Axes



Mark centers at both ends.

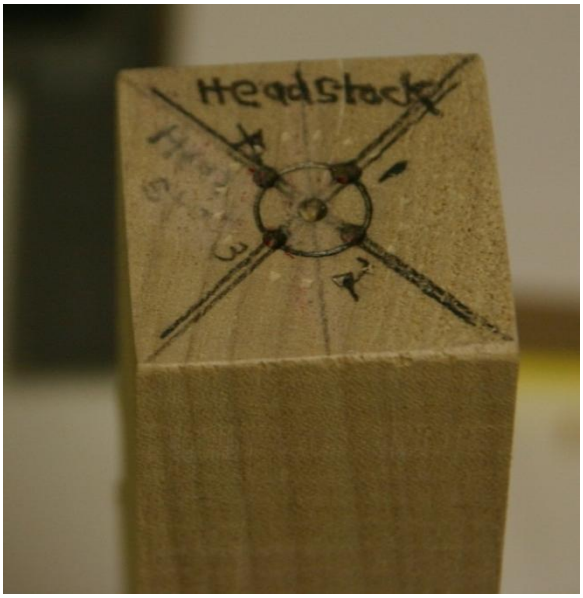
Use the tailstock to make a circular impression at each end.

Darken it with a pencil.

Use an awl to punch holes where the circle meets the lines.

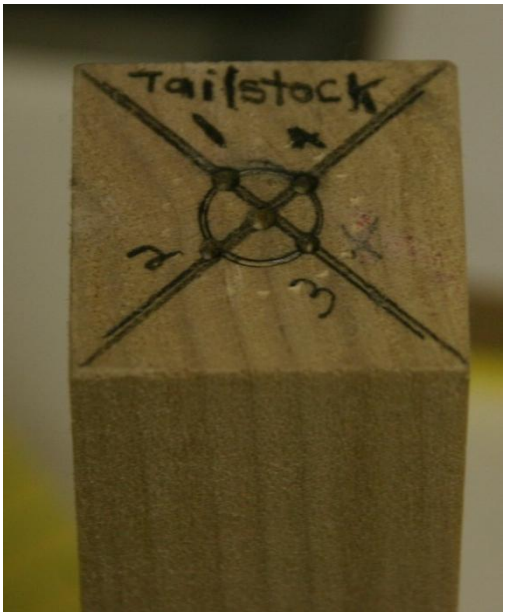
Number them **CLOCKWISE**.

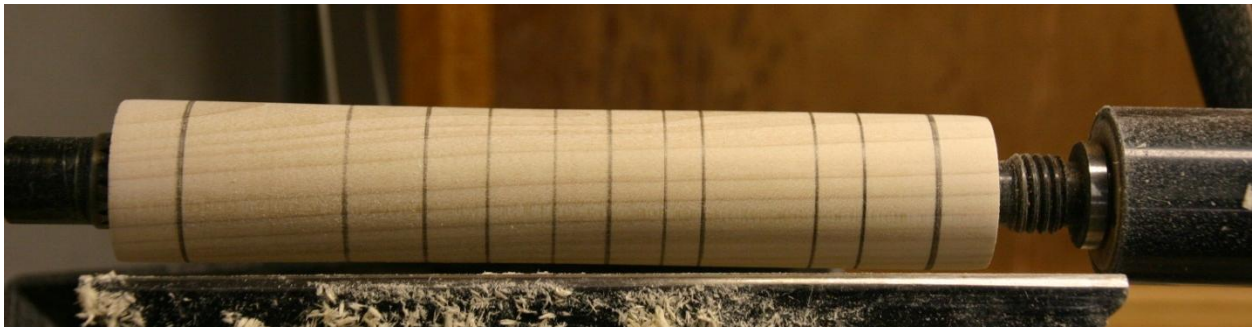
Label as “Headstock.”



Match the #1 hole on the headstock to the tailstock and label it #1.

Number the hole as #1 and number the other holes **COUNTERCLOCKWISE.**





Turn to a cylinder and sand to 220 grit.

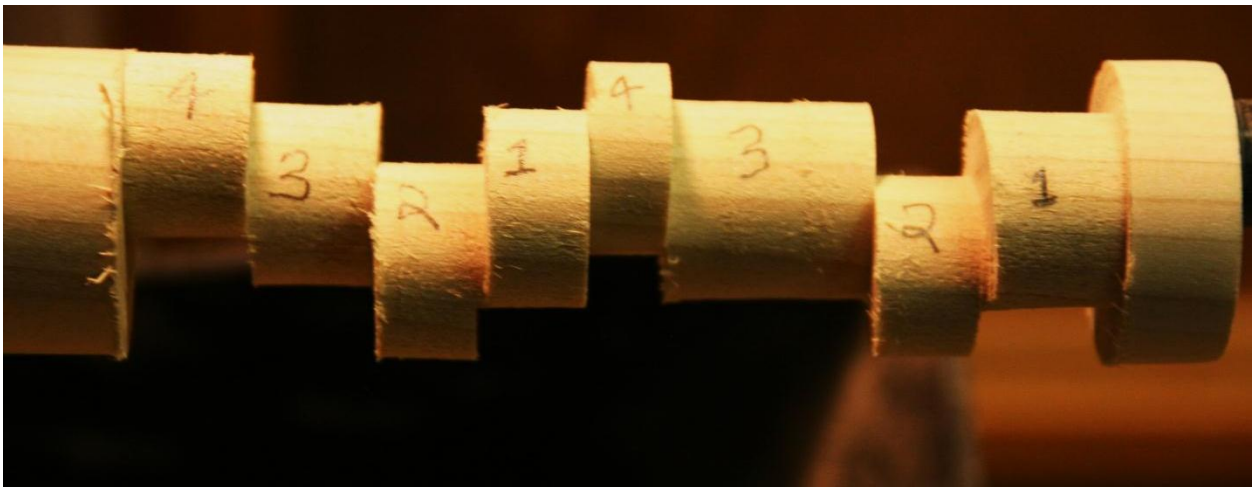
Draw lines to mark the length of each cylinder (**or not**).

Change axes in any order.

Always match the numbers: 1 to 1
2 to 2
etc.

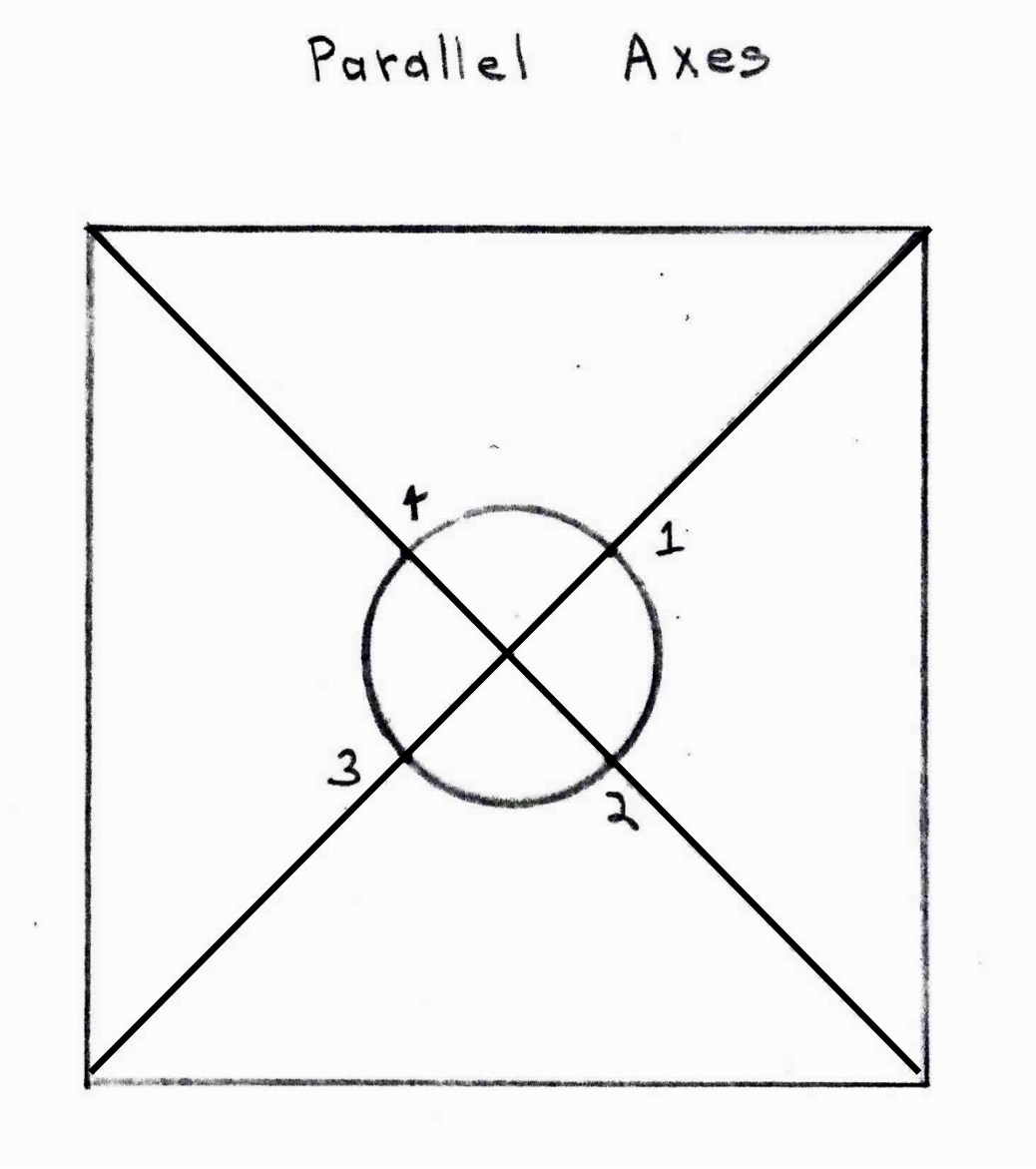
Sand as you go.

In this photo, the axes are numbered sequentially. However, feel free to ad lib.



Note: you are not limited to four axes.

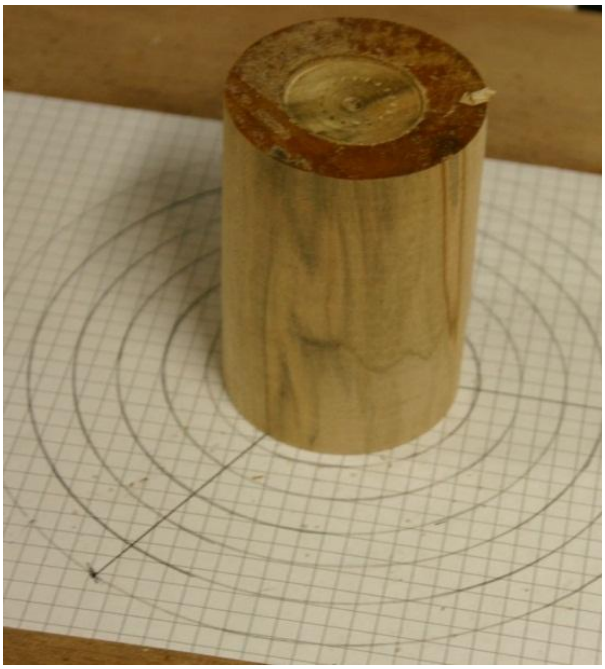
Diagram for Parallel Axes



Three-Sided Box

Turn to a cylinder

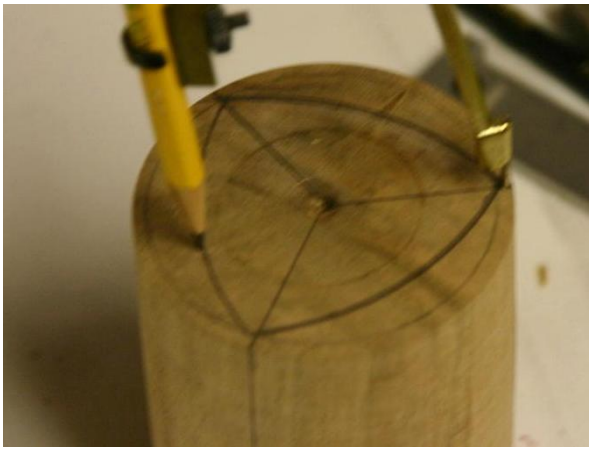
Mark 120 degrees.



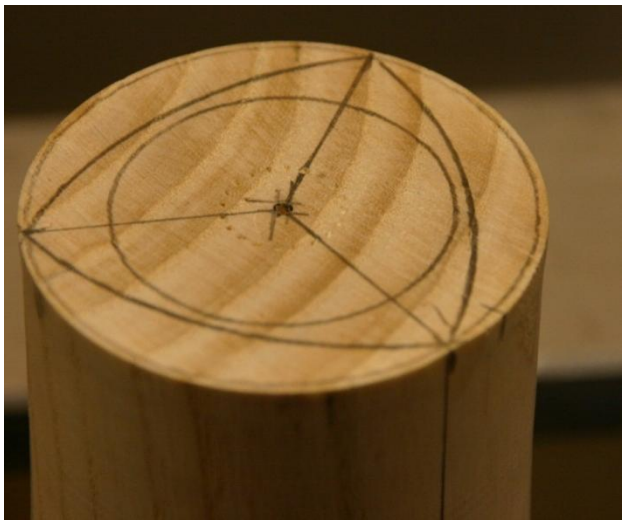
Transfer marks to side, top and bottom.

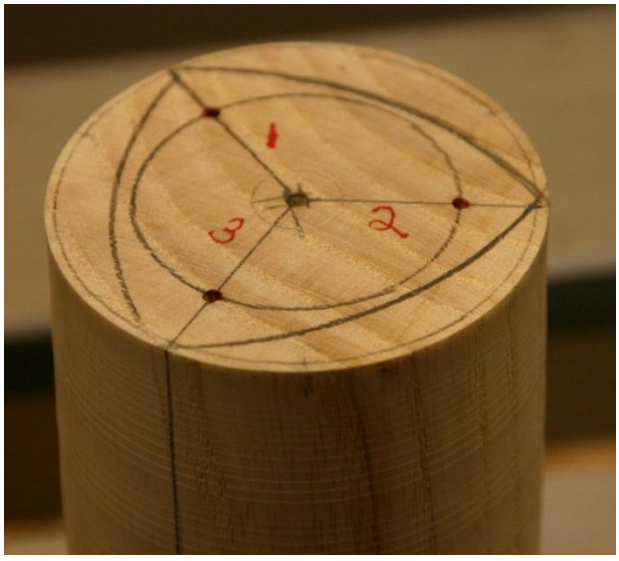
Draw line from the edge pencil marks to the center.

Using a compass, draw three arcs from each edge to connect each point.



Draw a circle within the boundaries of the curved triangle.
The diameter is your choice.
However, the larger the circle, the wider the turning will be. Check the next photo on page 3.





Using an awl, punch three holes on the circle, one at the intersection of each 120 degree line and number them clockwise.

Repeat the process at the other end of the cylinder, insuring that the numbers match each other: 1 to 1; 2 to 2; etc.

As you are removing wood, check both ends to make sure that you do not turn beyond the arcs. Check often.

Sequence: 1-1, 2-2, 3-3.

If you wish, use a parting tool and turn down to the line.

Do the same for the other side.

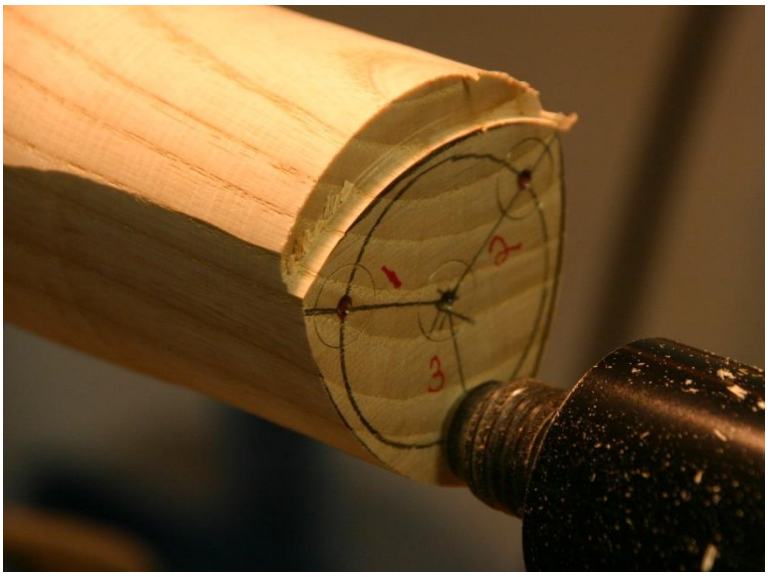
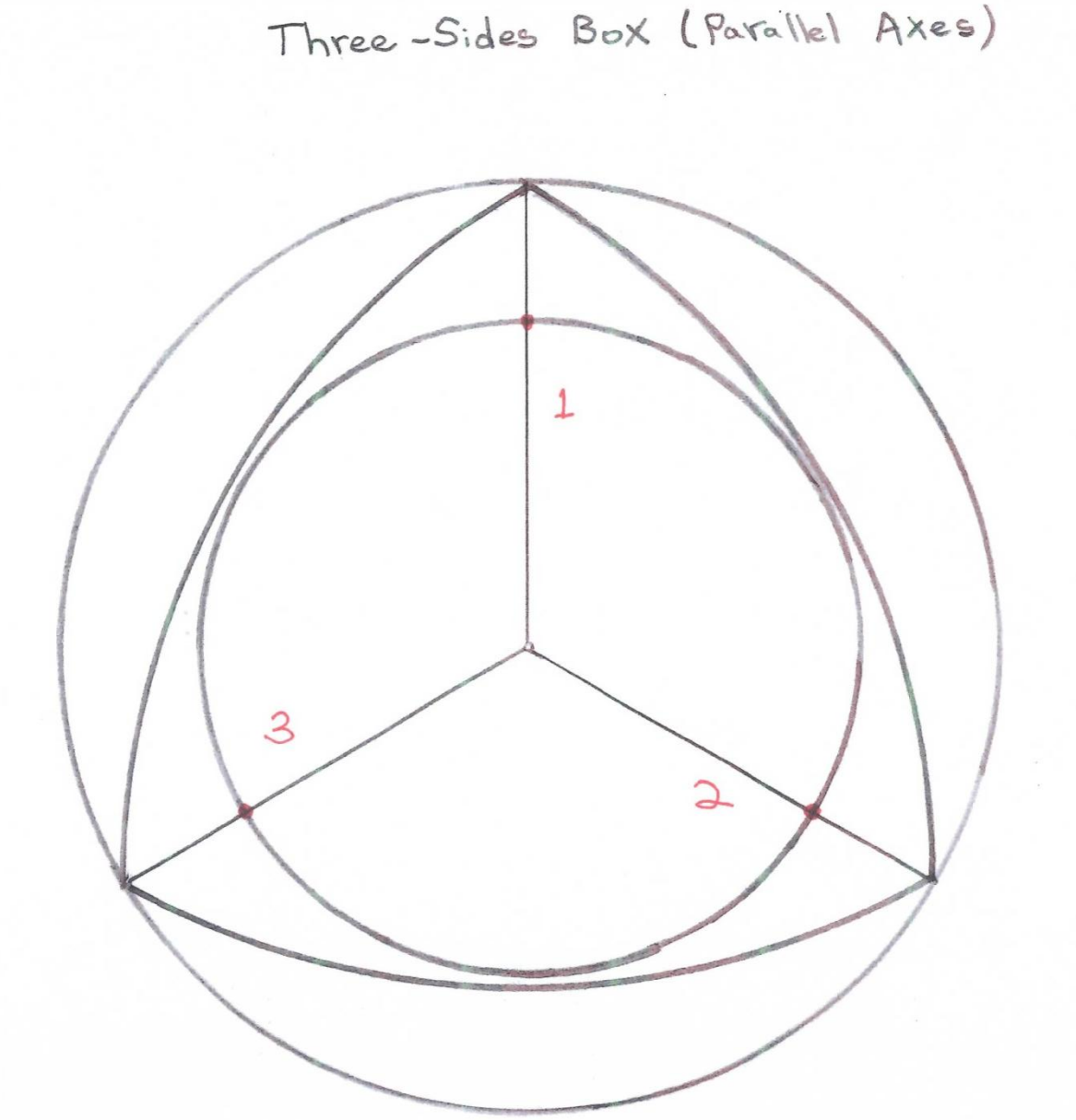


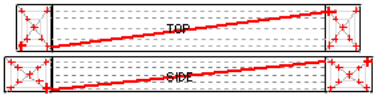
Diagram for Three-Sided Box



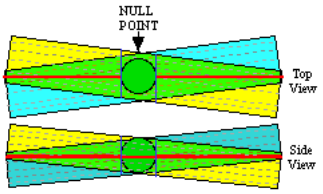
A Graphical Approach

A Graphical Approach to Generating a Between Centers Eccentric Turning "Plan"

by charlie b



1. Blank with selected centers and RED centeline between a given pair of centers for the top and side view.



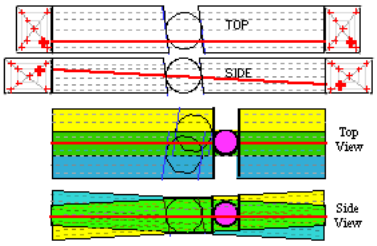
2. Rotate the TOP and SIDE views of the chosen Centers Pair such that the chosen Center Line is horizontal as it would be between centers on the lathe.

   Color the results in YELLOW

   Duplicate the results, flip it horizontally and color it BLUE.

   Align its centerline with that of the "YELLOW" version

   The resulltting GREEN area is the COMMON AREA. The remaining Yellow and Blue areas are the SHADOW AREAS

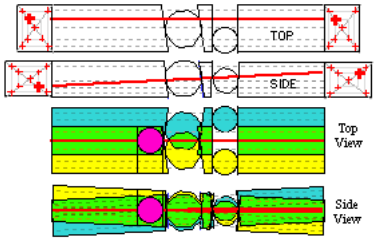


3. Begin with the results of the previous operation.

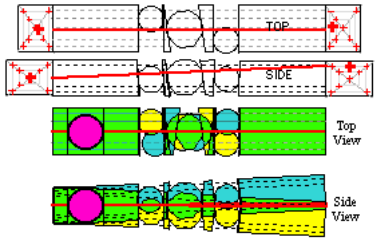
   Select another pair of centers and draw the red center line in both the top and side view

   Repeat the duplicate, flip and centerline alignment process described above

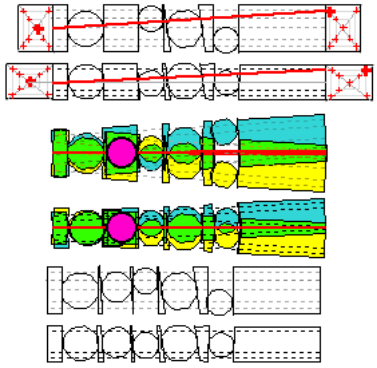
   Identify the largest bead that can be turned in the GREEN common areas, in this case it's the Top View that defines the maximum bead size



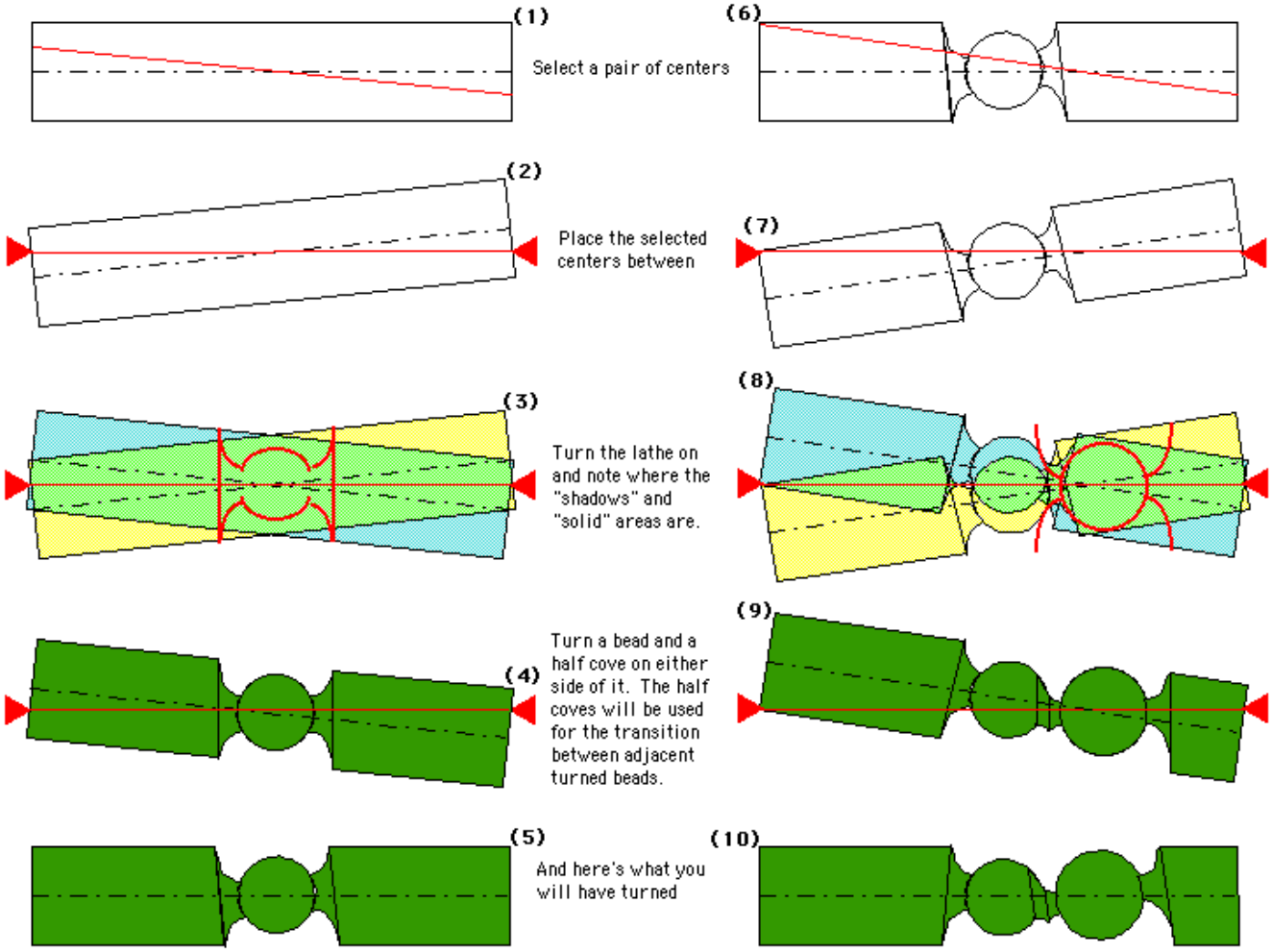
And so on



And so on



And so on


(1)
Select a pair of centers
(2)
Place the selected centers between
(3)
Turn the lathe on and note where the "shadows" and "solid" areas are.
(4)
Turn a bead and a half cove on either side of it. The half coves will be used for the transition between adjacent turned beads.
(5)
And here's what you will have turned
(6)
(7)
(8)
(9)
(10)

Informative Websites

Multi-Axis Woodturning
http://www.youtube.com/watch?v=7uZNmvwHHIY

Drinking Cup with a twist
http://www.youtube.com/watch?v=mRtAnredMr0&list=WLBE92AECB67AE0DDF

Fundamentals of two-Axis Turning
http://www.youtube.com/watch?v=4XhxUpglEOU

Off-Center Goblet
http://www.youtube.com/watch?v=_FhlScQmAfw

Woodturning Shop Made Jig for off-center turning
http://www.youtube.com/watch?v=zFM0zhpFpJ4

Jerry Bufalini