Have a Ball! Turn a [thin wall hollow] **Sphere.**

Handout

Primary Audience: Intermediate.
Time: 1.5 to 2 hours.
Prerequisites: None. Some turning helpful.

Objective.

The objective of this demo is to show you how to turn a thin wall hollow sphere using a template. The template method is easy to use, and success is not difficult when following two key guidelines. If making a ***Belted Ball*** refer to variations described later in this document.

Introduction.

Have you noticed? Many of the woodturning YouTube videos leave you in the dark about ***how*** to do what you just saw? This demo is *different*!

Sure, I'll show you how I do it, but what I really want to do is to help you learn how ***you*** can do it. There are several important tips to note along the way that will go far toward success the first time you try it and every time thereafter. Look for these points as we go through the process and be sure to ask questions if you don't understand (or if I forget to mention them).

Let's start with blank selection. In the beginning I had always chucked up a spindle (end grain) blank and waded in because that was how I had always done this kind of stuff. At some point between then and now, for reasons lost to an aging memory, I began rethinking the process. Here are two reasons to start with a face grain blank.

1. Face grain glue joints are much stronger than end grain joints. In a thin wall sphere, there is not much surface area in the glue joint, and there may be considerable stress on that joint in the turning process. I have had them fail.

2. The glue joint is virtually impossible to hide when it cuts straight across grain lines, but it may come close to disappearing when closely aligned with the figure.

A thin wall wooden ball is just two concentric spheres: one of air and one of wood. Here are two points to remember to solve the concentricity problem when turning the outside wooden sphere and you cannot ***see*** the inside sphere of air.

1. Pay close attention to the diameter guideline on the inside circumference template. It will help you place exactly half of the inside sphere on each side of the glue joint.

2. Pay close attention to the perpendicular guideline on the outside circumference template. It will help you place the outside sphere concentrically around the inside sphere.

Still ***honing*** your skills? Having trouble making things concentric? Give yourself some wiggle room. Do a few with a thicker wall and sneak up on your goal.

Enough of the introduction. If time permits, we'll make a template and fixtures to hold the sphere.

Start with the blank.

About 5/8" longer than wide for tenons e.g. 3 1/4" x 3 7/8" for a 3" sphere.

Option: Cut in half on band saw (while rectangular) instead of parting on the lathe for better grain matching. If the ends and center cut are not perfectly parallel the halves can slip out of alignment. Taping the joint may help the figure remain aligned, at least while tenons are cut.

- Consider grain orientation.
  - Glue joint strength.
  - Figure matching.
  - Laminations.
  - Desired final product.

Make a cylinder (or more cylindrical) between centers.

- A live center with point & cup in tailstock makes alignment during remounting easier in final steps.
- Mark center and left and right side limits. Include loss to parting kerf.

Make short (1/4") tenons to reduce mass to be removed later.

Reduce to desired outside diameter plus a little. (1/8")

Reverse mount in chuck so point & cup center marks both ends.

Part (if not cut with band saw).

Hollow chucked half.

- **This is a good place to take your time!**
- Refine face for glue joint.
  - Flat for maximum glue surface.
  - No groove on the outside.
- Define approximate inside diameter limit.
  - Make several concentric circles with a pencil.

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- Be aware of grain orientation, but *uphill / downhill* is not so important on the inside of a hollow sphere.
- **Turn the lathe off to measure the inside!**
- Where the template wiggles tells you where you need to cut.

> ***Trap!***
> Measure the inside with the template where the nub would be but with **NO NUB**!

Chuck 2nd half and hollow.

Remember! Inside and outside spheres need to be concentric and balanced between the halves.

> **Tip.**
> Rate of tool handle angle movement for hollowing a spherical profile is constant throughout the cut. This is different from many bowl forms where the curve changes slowly down the side, speeds up rapidly around the transition area, and slows down again toward the bottom.

Glue.

- Dry align figure with point centers and mark for ease of alignment with glue. White glue is ok in many cases. I prefer to use yellow wood glue (Titebond). I may use CA glue during a demo in order to continue with the same blank.
- Apply glue, align, & apply pressure with the tailstock.
- Remove from lathe after 5 minutes but maintain pressure for curing.
- Mark the I.D. on the outside.
- Allow overnight to cure.
- Continuing before the glue is cured results in a higher glue joint failure rate.

Now that we're finished with the easy part, let's...

Shape the middle of the outside of the sphere.

- **This is a another good place to take your time!**

> **Tip.**
> Many will tend to bevel from somewhere near the glue joint to the center of rotaton. Think about entering a parking space in a crowded parking lot.

- Mark sphere limit near tenons to define the target.
- Be aware of grain orientation for proper tool use (when you can).
- **The middle needs to be nearly perfect so it will self center properly in the next step.**
- Use quarter circle template. (Semicircle won't fit.)
  - Imperfections here will compound problems completing a perfect sphere.
  - The centerline of the outside template must align with the glue joint and be perpendicular to the axis of rotation.

Remount between cup chuck fixtures.

I used to half turn the sphere, rotate it 90 degrees between centers, and use a parting tool to create a groove, *witness line*, to guide completion of the sphere. (See *Witness Line Method* near the end of this document.) I now prefer to simply use the ***ghost*** of the half-completed sphere to guide completion.

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Ghost method.

- Cup chucks.
  - Use care when tightening the cup chucks. Too much pressure may fail the glue joint.
  - Padding that is too thick will interfere with self-centering.
  - The radius of the cup chuck must be equal to or less than the radius of the sphere.
- **A sharp gouge, patience, and a little extra finesse pay dividends here!**
- Placing a contrasting (dark or light) piece of material behind your view enhances visibility of the *ghost* of the half-turned sphere.
- Cut the remaining rotating ends to match the ghost sphere.
- Periodically check that you are cutting the sphere evenly.

Rotate and remount between fixtures as needed to sand.

Here's a suggestion to facilitate sanding coverage.

- Find a *directional feature* on the surface of the sphere.
- Sand.
- Rotate the *directional feature* 90 degrees about the *directional feature*.
- Sand.
- Rotate the *directional feature* 90 degrees to place the *directional feature* on the axis of rotation.

Remove and marvel at what you've accomplished!

Belted Ball Option.

- Allow for the thickness of the *belt* when sizing the blank, measuring for parting, and making the inside sphere congruent with the outside sphere.
- I make the *belt* part of one hemisphere which places it slightly off center.
- After beginning to hollow one hemisphere, glue the *belt* in place after making clean surfaces for gluing.
- Use a gouge to make a tenon / foot for the stand from the center of the *belt*.
- Use a parting tool to cut the center from the *belt*.
- Hollow the hemisphere with the *belt* keeping in mind the planned position of the *belt*.
- After the sphere is complete, turn the face of the stand to cradle the sphere.

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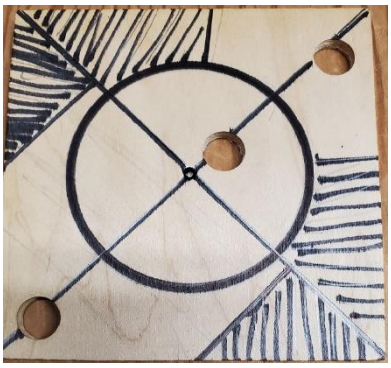
Making a template.



- Refer to the illustration.
- Use 1/4" plywood or similar material.
- Holes are for hanging together on a peg.
- Mount on the lathe with a supporting plate.
- Use a point live center.
- Use a parting tool to cut the inside template.
- The parting tool gap will be the wall thickness.
- Cut a full semicircle template from the outside part.
    - The inside template must include the line through the center.

Reference lines are important for making exterior and interior spheres concentric !

- Sand the semicircle edges.
- The outside templates (half circle and quarter circle) must have the perpedicular centerlines.
- The inside template must have the diameter line.
- Cut away the waste (shaded areas).

Witness line method.

- Plain spindle or chuck jaws and cup live center with pads may be used.
- Padded cup fixtures are helpful, but very thick pads (like from a mouse pad) can interfere with centering.
- Glue joint in line with axis of rotation vertically and horizontally.
- Original axis spinning perpendicular. (Center point marks spin in line.)
- Mark the line of rotation to be able to see where to place the parting tool.
- Use a parting tool to gently and check orientation of center points.
- Continue until the witness line approaches the glue joint.
- Check for even cutting on both sides.
- Remount between centers and continue shaping to the baseline.
- Rotate and remount to remove the remaining nubs.

Let's talk about gouge grind angle.

- When hollowing a hemisphere...
    - The bottom is perpendicular to the axis of rotation.
    - The mouth (where the glue joint will be) is parallel.
    - When the cutting tip of the gouge is on the bottom (dead center) and the shaft touches the side of the mouth, it is at an angle just over 45º.
    - Therefore, the bevel will stop guiding your cut before you get to the bottom if your gouge is not ground above 45º. I typically use 60º in these situations.

Frequently Asked Questions (FAQ).

Q: What gouge and grind do you use to hollow a sphere?

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A: (short version) The angle between the side and bottom of a hemisphere is 45 degrees relative to the axis of rotation. Therefore, the bevel angle of the gouge must be greater than 45 degrees to reach the bottom while guiding (rubbing) on the bevel before the shaft contacts the side. I use about 60 degrees.

A: (long version) In my early days of doing these spheres I had quite a sore left index finger knuckle. When I finally grew weary of the pain, I analyzed the problem and realized I was using too acute an angle on my bowl gouge. In hollowing a perfect hemisphere, when your gouge touches the side (mouth) it's cutting tip meets the center of the bottom (end of the cut) at ***something more than 45 degrees*** considering the thickness of the gouge itself. That means you cannot ***ride the bevel*** throughout the cut if your grind angle is 45 degrees or less. At some point you will lose the control the bevel provides. If that includes whizzing through the bottom, into the up-going far side of the sphere, it will take the tip of the gouge up, over the top, and down again to the tool rest. Ouch! Sore knuckle! To be able to ride the bevel to the end of the cut, it must be more than 45 degrees. I typically use 60-65 degrees. Of course, if your gouge is not sharp, you may be pushing too hard, and it may happen anyway, but that's another problem. Why not just hollow in the reverse direction or use a scraper? Those are both viable options, but they're not the usual way I do it.

Q: What kind of glue do you use?
A: I typically use yellow wood glue (like Titebond I) for a permanent bond. For demos I may use thick CA glue so we can proceed with the demo using the same blank.

Q: Do you use dry or wet (green) wood?
A: It's important to me to use dry wood because movement from the drying process could put a lot of stress on a very thin glue joint.

Q: Do you use the same size blank for a belted ball as for a regular hollow sphere?
A: I generally do use the same size blank, but that introduces extra wood that must be removed after the hollow hemispheres are glued together. If I am cutting blanks that I know will be used for "Belted Balls" I will allow for the extra mass of the "belt," and cut them appropriately shorter.

Q: Does it matter if you turn the sphere with end grain or face grain orientation?
A: It can be an important consideration for several reasons. First, end grain glue joints are not as strong as face grain, and the glue joint surfaces are typically very thin. Second, a glue joint directly across the wood fibers (grain) is virtually impossible to hide. Third, any figure alignment you wish to do is often easier if the glue joint runs with the grain.

References.

- Christian Delhon - Spherical Box – AW2004p44-49.pdf
- Frederick C Hill - Spherical Thinking – AW2504p29-32.pdf