Introduction
I got the idea for the Shadow Sphere Jig from an attempt to
make Inside/Outside Icicle Ornaments easier to turn. The
way I was trying to do the ornaments during the inside
turning required measuring the depth of the recess before the area
was fully round—which is kind of hard with calipers. I thought using
an overhead light and a marked paper on the lathe bed would let
me measure more easily. It didn't work very well. In fact, I'm still not
happy with the I/O Icicle, although I still work on it from time to time.
But I REALLY like the same idea applied to spheres. It's very
simple, just an overhead light and a circle pattern over the lathe bed. As
long as the overhead light is reasonably centered over the
sphere there's no distortion to deal with. It's freehand turning—not
mechanical drudgery. You can do all of the turning, including
removing the nubs, in spindle mode, so all of the cutting is
downhill to the grain. And then, using cup centers, you can switch
the ball around to a faceplate orientation with the end grain at
the maximum diameter where the sanding is more efficient.

Briefly, the article will describe
making an above banjo platform to
hold the pattern, and then a
hanger for a light such as an LED flashlight. Then it will describe
making cup chucks for the
headstock and tailstock. Then the
basic sequence for turning,
sanding and finishing spheres will
be described. Then three
chucking methods to make
removing nubs or doing post
sphere work will be shown.

cup/blue tape, PVC sleeve, and
wooden jaws.

Platform
The platform doesn't take a lot of stress as it only holds a piece of
dpaper still. About the greatest
force on it comes from blowing off sawdust. Because of this it only
needs to be supported at one end
and magnets on the bottom suffice
to hold it in place. This lets you
take it on and off the lathe quickly,
and it doesn't interfere with
movement of the tool rest banjo.

First we'll discuss making a
platform for small to mid-size
lathes, then mention modifications
for large lathes. Start by taking a
few measurements. First measure
the height of the horizontal arm of
your toolrest banjo. Fig01 shows
doing this with a combination
square. Add 1/8” to this for the
height of your platform support.
Next measure the width of your
lathe bed. Add 1” to his for the
length of the platform support.
Now cut a board (5/4 pine or
construction 2x4 is fine) to these
dimensions. Also cut a stop block
from the same thickness board
1/2” wide and 1” long. Apply glue
to the stop block piece and clamp
it to the platform support lined up
with one end as in Fig02. Allow
the glue to set.

After the glue has set, remove the
clamp and lay the platform support
on its side on the lathe bed with
the stop block lined up with the
back edge of the lathe bed as in
the top image of Fig03 and mark
the center of the lathe bed rails.
Then take the platform support to
your drill press and drill two 1”
holes 1/8” deep at the marks as in
the bottom image of Fig03. Use
CA glue to glue in 1” round rare
earth magnets as in Fig04.

Platform

Fig01  Measuring the height of the
banjo with a combination square.

Fig02  Marking the location and
drilling holes for rare earth
magnets.

Fig03  Clamping the stop block to
the platform support while the glue
cures.

Fig04  Glueing in the magnets.
After the CA glue has set, return the platform support to the lathe and place it magnet side down with the stop block against the back edge of the lathe bed directly under a drive center placed in the headstock. Use a square to find and mark the center line of the lathe on the platform support as in Fig05.

Make additional marks 1" on either side of the center mark on the platform support. Cut the platform from 1/4" plywood 2" wide by 8" long. Screw this to the platform support between the marks so that the platform is centered on the lathe axis and at a right angle to the platform support, as in Fig06.

Secondly, the further the platform is from the sphere the fuzzier the shadow will be. It would be entirely more sensible to plan on a maximum sphere of somewhat less than 8". Measure the distance from the lathe bed to the lathe center and subtract 8". Cut your platform support to that width, then follow the directions as for a smaller lathe. The completed large lathe platform is shown in place in the right image of Fig08.

The shadow sphere jig requires a more or less point light source that is directly above, and movable along, the lathe axis. This article will describe a way of doing that for lathes that are situated in a basement (as I think nature intended) with exposed joists. If your lathe is in a more upscale location you will have to work out another method of supporting the light hanger, such as a post mounted to the lathe bench. LED flashlights are not exceptionally heavy devices, so a simple 2x2 or 2x4 post should be more than adequate.

The light hanger consists of 2 2x2 boards screwed together at a right angle. My hanger has a 13" vertical piece and a 23" horizontal piece but you may want to resize things to suit your situation. The horizontal piece should be long enough to bridge joists to place the light where it's needed. The vertical piece should be long enough to get the light down to a height you can reach to turn it on and off. Just screw the two pieces
together at a right angle as in Fig09.

Fig09  Two 2x2's screwed together to make the light hanger.

Now make a V-block to hold your flashlight or other light in place. Cut a piece of 2" x 2" about 3" long. With your bandsaw, cut a V-notch on one long face about 1/2" deep. Then cut a notch out of the opposite side as in Fig10. The V-block, with the aid of a clamp, will hold the light. The notch will register on the light hanger and keep the light perpendicular as is shown in Fig11.

Fig10  The Light V-Block

To mount the light over your lathe, use one clamp to hold the hanger to a joist, and another clamp to hold the light and V-block to the hanger. You can adjust the hanger along the joist to center the light on the lathe axis, and you can move the light along the hanger to center the light over the sphere you are turning. Fig12 shows the hanger mounted above my lathe. It's a rather busy picture, as I store things between the joists. I'm using an Ikea goose neck desk light instead of an LED flashlight, as it's a little brighter and it doesn't matter as much if I forget to turn it off.

Fig12  A desk light mounted with the hanger to the ceiling above the lathe.

It's important, to avoid turning ellipses, to have the light centered over the center of the sphere (or at least within a few inches). You can tell if it's on the lathe axis if the drive and tailstock centers project on the center line of the platform. You can easily turn an aid to check alignment up and down the lathe axis. Between centers, mount a 1" square by 2" long piece of wood. Undercut the rim at the tailstock end so it will sit flat on the platform. Then turn a flat shelf leading to a small straight cylinder and cut it off at the headstock end. The centering indicator is shown in Fig13. The indicator is placed where the middle of the sphere will be. In this picture the shadow projects towards the headstock end, indicating that the light should be moved towards the headstock.

Fig13  Using the centering indicator to align the light along the lathe axis.

Tailstock Cup Center

Although the Shadow Sphere Jig allows you to almost complete turning the sphere while mounted between centers, sanding and finishing work better with cup centers. And cup centers work better if mounted on the headstock and tailstock. To make a cup center to mount on the One-Way live center first cut a square of pine (there's no need for expensive wood as construction lumber will work just fine--in fact soft pine is less likely to dent your sphere) about 2" thick and as big as the cup center you want to make. 1-1/2" to 2" is a good width to start with for the cup center blank. The piece will be turned in faceplate orientation so that threads can be tapped. Mark the center of the square and pin the square to something with a flat surface mounted on your headstock spindle. Since a 4-jawed chuck with #1 jaws will be used later in the process, you can fully close the jaws and use the chuck. Turn a round tenon on the cup center blank with a bowl gouge as in Fig14.

Fig14  A round tenon on the cup center blank with a bowl gouge.
Fig14  After turning a tenon on the cup center blank.

Now mount the cup center blank by the tenon in the 4-jawed chuck with the shoulders of the tenon registering on the faces of the jaws for better accuracy. Create a starting dimple in the center of the blank by turning with the point of a skew or by drilling with a spotting drill. Now mount a drill chuck with a 21/32" drill in your tailstock and drill through the blank as in Fig15. Mount a mini-tap guide in the drill chuck to keep the tap aligned. Place the nose of a 3/4x10 tap in the drilled hole and bring up the mini-tap guide so that the point is in the dimple in the back of the tap. Compress the point of the mini-tap guide and turn the tap to cut the threads all the way through the blank as in Fig16. My tap wrench was too big for the swing of my lathe so I used an adjustable wrench.

Fig15  Drilling the cup center blank for tapping.

Remove the cup center blank from the chuck. Find a common nail that will fit in the hole in the side of the live center body and cut it to the diameter of the live center. Secure the nail with masking tape. Screw the cup center blank on to the thread of the live center. You could turn the cup center by mounting it in the headstock Morse taper, but it tends to vibrate out, so mount the tailstock in the 4-jawed chuck as in Fig17. Place the protruding nail head between jaws. Turn the blank round and then turn a fairly shallow conical recess on the end of the blank as in Fig18. Also round over the rim of the cup slightly.

Fig16  Tapping the cup center blank with the aid of a mini-tap guide.

Fig17  The tailstock with cup center blank mounted for turning.

Fig18  After turning a conical recess in the end of the cup center.

Optionally, remove the cup center from the tailstock and trace its diameter on a piece of 2 mm craft foam. The foam will make the cup center less to slip or dent your spheres. Spray the foam with spray adhesive, as in Fig19. Wait for the glue to dry as per the instructions on the can and then attach the foam to the cup center. As the center of the cone is drilled out, the foam will stretch enough without cutting. Fig20 shows the complete tailstock cup center.

Fig19  The set-up to spray adhesive on craft foam for the recess of the cup center

Fig20  The completed tailstock cup center.

Headstock Cup Center
You could make the cup center for the headstock the same as the tailstock and drive it with a chuck held piece of 3/4 x 10 all-thread. But it's probably less trouble to turn a cup center with a tenon to hold directly in a chuck. Since pine is still a sensible choice, a cup with a tenon will be stronger if turned in spindle orientation.

Mount a piece of pine big enough to make the size cup center you want (2" x 2" x 3" is a good starting
place) between centers and turn a
tenon on the tailstock end to fit the
chuck you want to use as in Fig21.
I'm planning on using my collet
chuck with a 3/4" tenon, as it's
small, finger friendly, and doesn't
get in the way. A 4-jawed chuck
would also work—just make it with
a longer nose so the sphere isn't
real close to the chuck.

Fig21 After turning a tenon on the
headstock cup blank.

Once you've formed the tenon,
mount it in your choice of chucks
and turn a shallow recess as in
Fig22. Optionally you can add a
craft foam cushion.

Fig22 After turning a recess in the
headstock cup chuck.

Turning

To turn a sphere mount a turning
square of wood between centers
on the lathe. The piece should be
3/4" to 1" longer than the intended
sphere. Turn the wood to a
cylinder with a spindle roughing
gouge. Remove the cylinder from
the lathe and place the platform on
the lathe. Turn on your overhead
light and place the centering
indicator on the platform mid-way
between the drive and tailstock
centers. Adjust the light so it is
centered over the centering
indicator. Then remove the
centering indicator and replace the
cylinder on the lathe.

Cut a piece of white poster-board
(or cereal box cardboard if you're
desperate and/or cheap, but you
can't see the lines as well) 1/2"
wider than the cylinder and an inch
or so longer. Clip it to the platform
with binder clips. Make a mark
corresponding to the centering
marks on the platform at each end
of the poster-board. Now make a
mark at the shadow of the edge of
the cylinder, or slightly inside it, in
the middle of the poster-board at
front and back as in the top image
of Fig23. Remove the poster-
board from the platform. Connect
the center marks with a line Use a
square to draw another center line
through the front cylinder edge
mark perpendicular to the front
deck. Then use a compass to
draw a circle. The center of the
circle is the intersection of the
centering lines and the cylinder
ege marks indicate the radius.
The result is shown in the bottom
image of Fig23.

Fig23 The steps in making a
circular template for the sphere.

If you would rather do the math
and use a predetermined template,
with highly visible fine black lines
on white paper, you can use a
CAD program to print out a
template. The template is just a
horizontal line and a circle. The
diameter of the circle needs to be
slightly larger than the sphere you
want to make. Measure the
distance from your light to the lathe
axis and call this SOD (Source
Object Distance). Also measure
the distance from the light to the
platform and call this SID (Source
Image Distance). If we call the
Template Diameter TD, and the
Sphere Diameter SD, then TD =
(SID/SOD) * SD.

Clip the circular template back on
the platform. Check to make sure
that the shadow edges line up with
the circle and that adequate nub
length is left at both ends as in
Fig24.

Fig24 After replacing the
completed circular template on the
platform.

Turn the lathe on at a sensible
speed and use a spindle gouge to
start beveling the tailstock end of
the cylinder as in Fig25. Watch
the shadow so that you don't
remove too much. Now,
continuing with the spindle gouge,
start turning the beveled cylinder
so that the shadow matches the
circular template. Don't try to hog
it directly down to size, rather cut
away layers like peeling an onion.
The tip of the gouge will cover up
the edge of the sphere's shadow
on the front. If you can, look over
or around the sphere to the back
edge so you can see what you're doing when you're doing it. If you can't get in a position to see the shadow on the back of the circular template you'll have to check your progress by pulling back the gouge frequently. If you do remove too much, you can regard it as practice and shift the template position slightly towards the headstock. Fig26 shows the sphere after turning the tailstock end.

Fig25 After beveling the cylinder to remove the bulk of material.

Fig26 After turning the tailstock half of the sphere.

Now use the spindle gouge to bevel the headstock end of the cylinder as in Fig27. Then form the spherical shape on the headstock end as in Fig28. It would save sanding time if you use a shear scraper to refine the shape and surface at this time. A pyramid point tool would be the easiest to use here.

Fig27 After beveling the headstock end of the cylinder.

Fig28 After finalizing the shape of the sphere.

At this point you can return to the nubs and, still following the shadow on the template, reduce the nub attachments to very small diameters. In production mode, you could cut off the nubs with a fret saw and proceed to sanding between cup centers. In the more fun "turn as much as possible" mode, you can make one of the jigs later in the article, or you can make do with only the cup centers. Replace the conical live center with a tailstock with a mounted cup center as in Fig29. Tape the sphere to the cup center with extended release masking tape as in Fig30. This will save having to chase the sphere around the shop. Then, following the shadow on the template, cut free the headstock nub as in Fig31.

Fig29 Substituting the cone cup center for the original tailstock.

Fig30 After taping the sphere to the cup center.

Fig31 After cutting the nub free on the headstock end.

Remove the tape and turn the sphere around so that the tailstock nub is at the headstock. Bring up the cup center and tape the sphere to it as in Fig32. Then turn away the second nub now at the headstock end.
Now mount cup centers at both headstock and tailstock. Mount the sphere between the cups starting with the end grain exposed as in Fig33. Mount the sphere firmly—if you let the drive cup center slip against the sphere you may burn unintended circles. You may notice that the sphere magically changes from maple to mahogany in Fig33. This because I got lost in the turn/photo sequence and forgot to shear scrape before removing the nubs. Now start sanding. This is essentially the same as bowl turning with considerable end grain, so start with an appropriate grit. There is some margin for error in mounting the sphere between cups. I do not suggest doing any further turning as you could end up chasing the ghost until the sphere disappears. If the sphere isn't running true, try remounting the sphere and/or just turn down the speed so that the abrasive can follow the surface evenly. Sand with the coarsest grit (I started with 100, but use what's appropriate to the surface left by your tools. Then rotate the sphere so that the area covered by the cups can be sanded. I suggest turning the sphere so that the end grain, which will need the most sanding, is still exposed, and finish sanding with the coarsest grit. Then switch to the next grit and sand, then rotate the sphere to sand the area covered by the cup centers. Continue in the fashion to your final abrasive.

You can apply a friction polish on lathe if you wish. Leave the sphere mounted between cup centers after sanding. Apply friction polish to the sphere. Wait for the finish to fully harden (have a cup of coffee, say) then rotate the sphere as when sanding. Be sure to tighten the cups sufficiently that the drive cup can't slip against the already finished sphere and apply finish to the areas covered by the cup centers as in Fig34.

Pin the sphere against the cup chuck and apply thin CA glue to the junction of the two taped surfaces as in Fig36. CA glue is appropriate because it penetrates the joint between the tape and sets quickly. If the sphere still has a nub, pin it with the tailstock center used to turn it. If the sphere has been de-nubbed, use a tailstock mounted cup center. Let the glue set adequately and then do your turning. Applying sideways pressure should allow you to remove the sphere. It holds surprisingly well, although perhaps not up to a major catch. Fig37 shows the 3" pine sphere I hollowed using rather crude hollowing tools.

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**Cup/Blue Tape**

When removing nubs, hollowing, or doing other post-sphere manipulations, it's nice to be able to hold the sphere in a chuck without damaging it. One method is use a cup center you've already made (although it should not have craft foam). Apply extended release masking tape to one end of the sphere and to the inside of a headstock mounted cup center as in Fig35. Sanding the tape lightly will remove a coating on the tape and allow better glue adhesion.
Fig37  Sphere hollowed using a cup chuck and blue tape.

PVC Sleeve
If you have tower jaws you can use a PVC pipe sleeve and a 4-jawed chuck to hold the sphere without marring it. #2 tower jaws will hold up to a 3" sphere. #3 tower jaws will hold up to a 4.5" sphere. Cut a piece of PVC pipe so that it is slightly longer than half the sphere diameter. Mount the PVC pipe in your 4-jawed chuck and true up the rim. Then bevel the edges slightly. Then reverse the pipe and true and bevel the other end.

Remove the PVC from the chuck and cut it lengthwise on one side. See if the ring fits around the sphere. If the edges overlap, then remove an appropriate amount with another cut. Place the sphere and PVC sleeve in the chuck with the gap in the sleeve between jaws and tighten it. Then turn as desired. Fig38 shows a 3" pine ball hollowed using the PVC sleeve.

Fig38  PVC sleeve and sphere mounted for hollowing.

If the pipe diameter is so different from the sphere diameter that it is difficult to open enough to fit, or difficult to close once around it, you can use heat to set the PVC to a new shape. One way is to mount the sleeve in the chuck compressed to the appropriate size and use a heat gun to warm the PVC until it seems less springy. Then let the PVC cool.

Another way, if your spouse isn't home and the weather allows for ventilating the kitchen, is to heat the sleeve in an oven preheated to 220 degrees for 10 minutes. Remove the sleeve (and any other evidence) from the oven with pot-holders or gloves and quickly chuck up a sphere in the chuck and allow the sleeve to cool.

Wood Jaws
Wood jaws for the 4-jawed chuck are an efficient way to hold the sphere for de-nubbing or hollowing. However they are a bit more work. There's an article on my web site about making wooden jaws. You will need a hard wood at least 1/2" thicker than the radius of your sphere. Briefly, cut wooden triangles, then drill and countersink them for your mounting screws. Mount the jaws on your chuck. Grip a 1/2" piece of wood in between the jaws, and turn the lathe on at a moderate speed and turn the rim round. Then hollow a cylindrical recess (if you try to hollow a sphere it will push the sphere out when tightened) as in Fig39. Fig40 shows a sphere mounted in the wooden jaws.

Fig39  Wooden jaws turned with a cylindrical recess.

Fig40  Sphere mounted for turning with wooden jaws.

Tools and Materials
Small pieces of Pine, either 5/4 or 2x4, for the platform.
2 1" rare earth magnets
Drill press
1" forstner bit
CA glue
1/4" plywood, about 2"x8" for platform
Combination square
2" x 2" pine for light hanger and light block
clamps
LED flashlight or desk lamp with small light source
Maple scrap for centering indicator about 1"x1"x2"
Small pine blocks for cup centers
One-way tailstock
21/32 drill bit
3/4"x10 tap

3M 77 spray adhesive
small bowl gouge
poster-board
pencil
compass
binder clips (available at office supply stores)
turning squares for spheres
spindle roughing gouge
spindle gouge
pyramid point tool
Blue masking tape
Optionally:
PVC pipe
maple for wood jaws
Mini-tap guide (available from any industrial supplier)
2mm craft foam (available at any craft store or Wal*Mart)

Author
David Reed Smith turns and tinkers in his basement in Hampstead, Maryland. He’s been working half-time for 7 months now, and is 18 months to Medicare. He welcomes comments and questions and pictures if you try the sphere jig out via email at david@DavidReedSmith.com.

This article, along with 60 others is available on his web site www.DavidReedSmith.com.