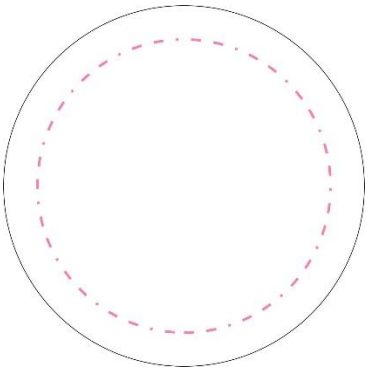
Turning a Multi-Axis Pumpkin Box

In this demonstration, we will turn a wood pumpkin utilizing a modified octagon process and multi-axis techniques. As a prerequisite, reading and practicing turning a sphere is highly recommended. (See separate handout).

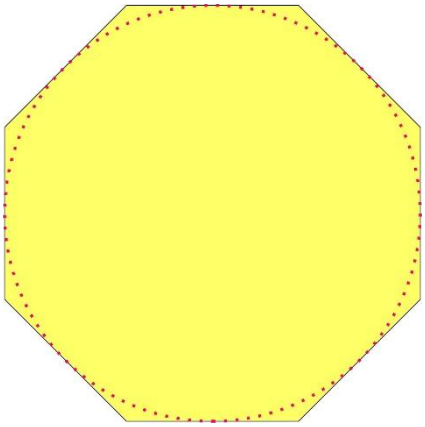
Overview

The essence of the octagon process for turning a sphere is the observation that a circle can be perfectly inscribed in an octagon. By the way, a lathe is great at turning a 2D representation into 3D reality. So, a 2D circle becomes a 3D sphere; A 2D octagon becomes a 3D octahedron (of sorts). Observing the points and measuring the octagon gives essential guidance to turning the inscribed sphere. These measurements have been solved for you (it is a bit of geometry and algebra).

Turning a Multi-Axis Pumpkin Box



Let us start by observing that our pumpkin will evolve from an octagon, to a sphere and finally to a pumpkin with some hollowing and eventual shaping to form the characteristic pumpkin shape.



How will an octagon help us? An octagon gives us eight points and eight sides that guide our initial turning. However, since an octagon is a regular polygon, we need only two measures: The length of the octagon's side and the horizontal distance between the right side of the octagon and its nearest corner. More on that later.

We start with a cylinder whose length is about ***1.25 times its diameter.*** The key points are all mathematically derived from the diameter measure(d). Therefore, we can start with any diameter of a cylinder and then by multiplying its diameter measure by two factors, layout key points on the cylinder. Here is where we modify the octagon process to extend it to obtain key points for our pumpkin. The pumpkin needs a body and a lid like a traditional box.

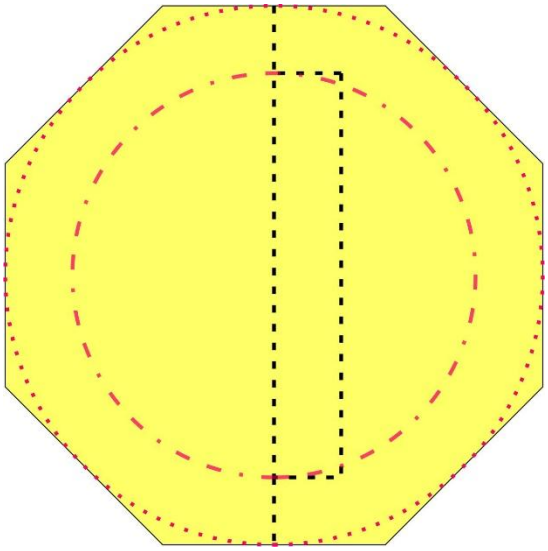
Joint Options

We have multiple options for the position of the lid on the cylinder.

Option A

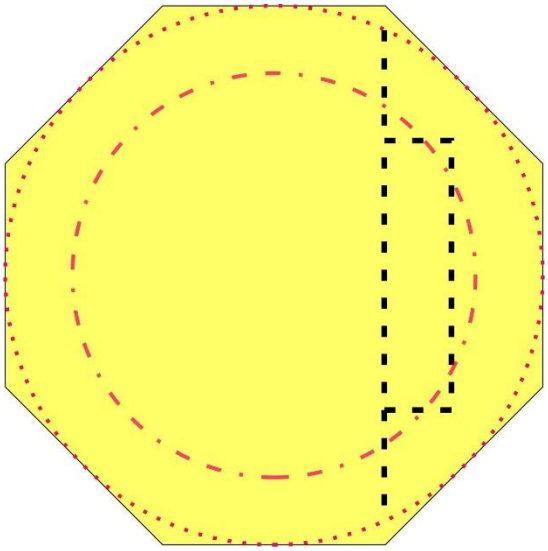
Part the pumpkin sphere at about 50% of the height and form a traditional mortise and tenon for the joint. The advantage of this option is that it preserves more wood near the joint and lid

mortise. The disadvantage is the lesser cavity volume in the box base. This option is described in this write-up.



Option B

Part for the pumpkin lid anywhere higher on the pumpkin up to the next corner of the octagon. The advantage of this option is the greater cavity volume in the box base. The cavity volume in the lid is less but not a significant factor. The disadvantage is greater short grain at the joint. Short grain is much more chippy. Application of thin CA glue may help reduce chipping the edge of the lid.

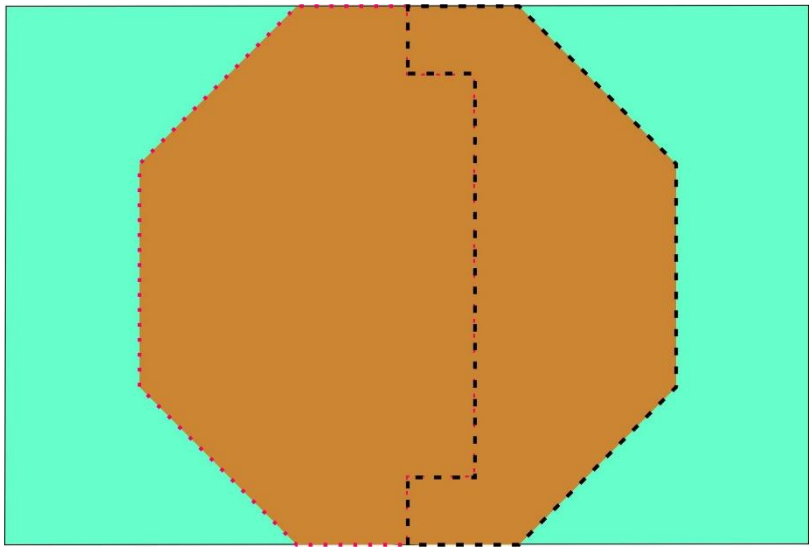


Option C

Part for the pumpkin lid halfway along the top slope of the octagon side. To me, this is the most aesthetically pleasing. However, forming the joint is more difficult with significant chipping of the joint edge short grain.

We now continue to describe option A.

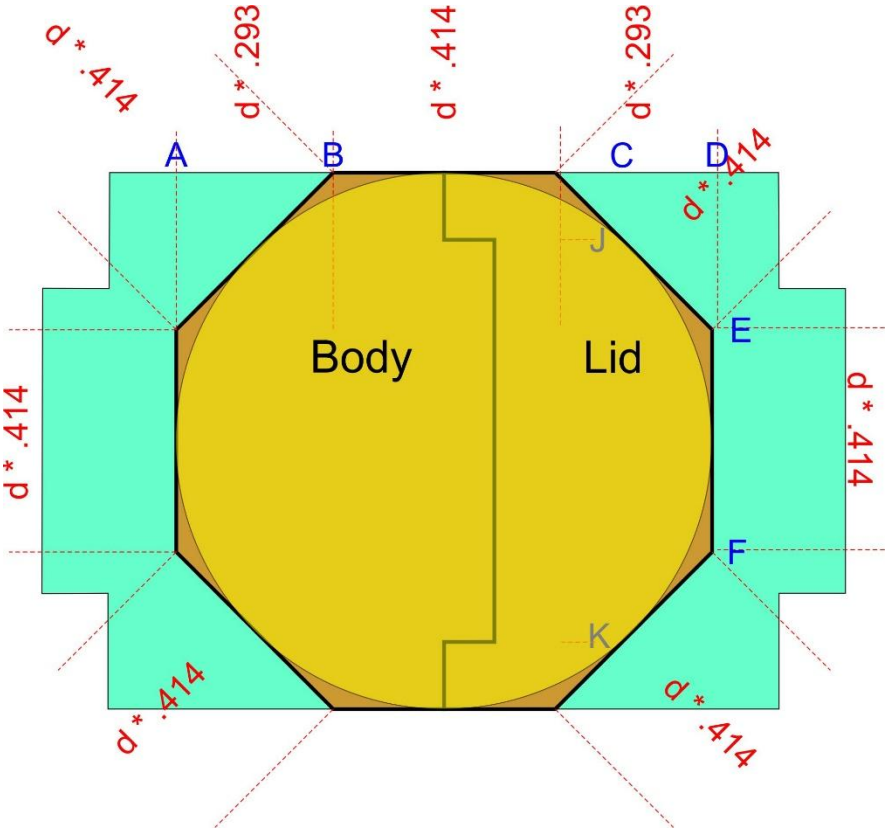
Step 1 – Turn a cylinder.



Mount the wood between centers and turn it into a cylinder. Ensure the diameter is consistent along the cylinder. True the ends of the cylinder. Measure the diameter. This measure is key to laying out all key points for the octagon containing the pumpkin. An octagon has eight sides all of the same length which is the diameter times 0.414. However, since the octagon is still contained inside the wood cylinder, we do not yet have access to four of the sides. We need to project the key point up to the side of the cylinder. Therefore, if the cylinder were to be trimmed to the same length as the diameter (which brings us closer to a square and then a circle, the corresponding point is diameter times 0.293. This is the distance from the corner of the trimmed cylinder to the corner of the octagon. BTW, this line is also 45 degrees down from the cylinder's side. You will use this measure twice at both ends of the cylinder.

As a check on your math, add two end factors and the side measure and compare this total to the diameter. These should be equal. If not, it is better to find out now and make corrections.

Step 2 – Layout points for the pumpkin body and lid



Line AB is the 0.293 factor.

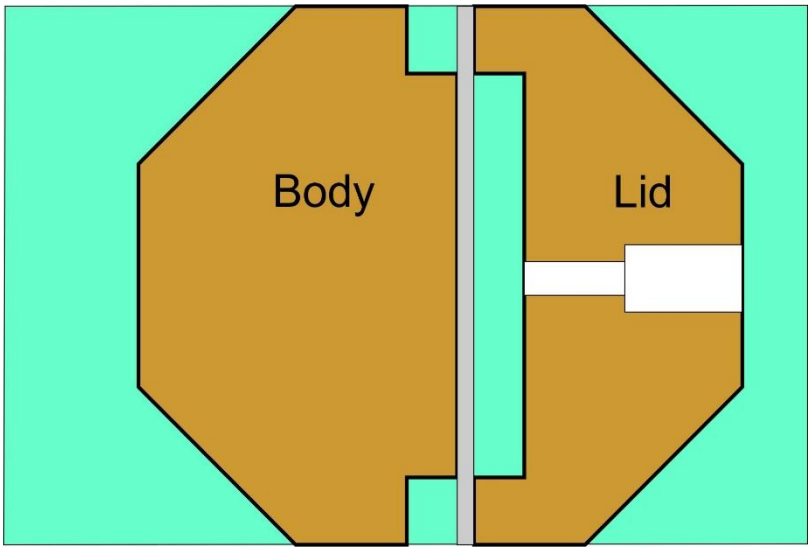
Line BC is the 0.414 side factor.

Line CD is a 0.293 factor.

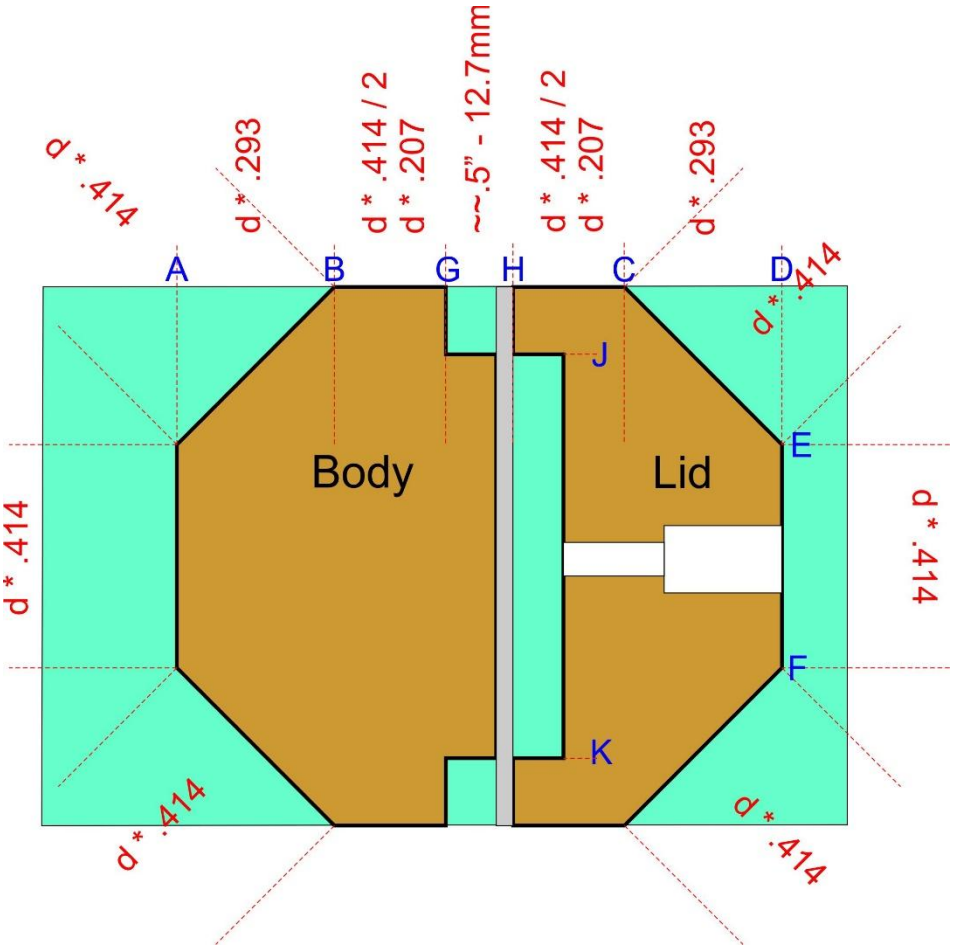
Line EF is the 0.414 side factor.

This is the body of the pumpkin.

Turning a Multi-Axis Pumpkin Box

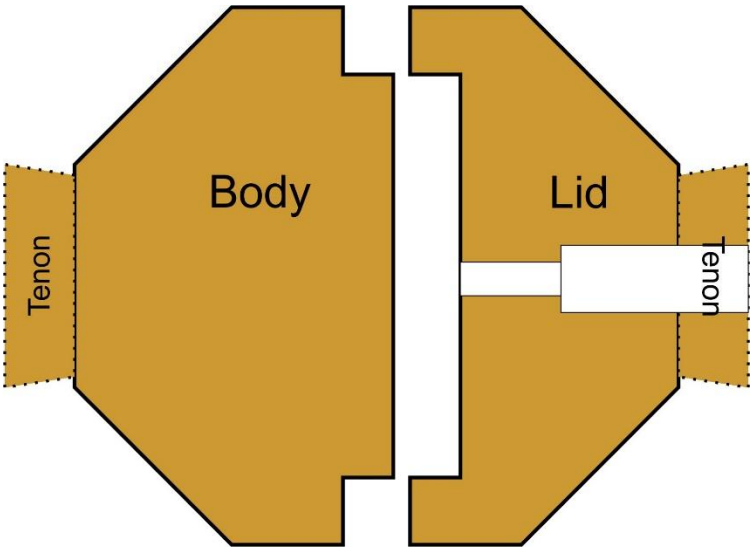


But, hold off from marking these points on the cylinder – We need to create an allowance for the joint. We need to stretch the layout at the joint and allow for enough wood for the parting kerf and wood for the mortise and tenon.



To stretch the octagon, let's add points G and H between points B and C. Line BG is one-half of a side or diameter times 0.207. Line HC is also this same length. The amount of wood is denoted by the line between G and H. It must be enough for the saw kerf and the length of the tenon or depth of the mortise.

Step 3 –Prepare to hold the pieces and form pumpkin body and lid



With all points marked on the cylinder and lines drawn around the cylinder by rotating the cylinder under the pencil, we can start serious turning for the exterior of the base and lid pieces. Start by forming tenons on both ends of the cylinder that will securely mount each piece. Then part the two pieces into two individual pieces: Lid and base.

Lid:

It is nearly always easier to fit a tenon to the mating mortise. So, mount the lid on the tenon and cut the mortise first. Recommended that the diameter of the mortise be the outer diameter less 1 inch or 25mm. This difference allows for future exterior flutes on the pumpkin. Greater than 1 inch could provide more safety wood for flutes and expansion mount pressure.

Also turn the slanted side of the octagon.

Using the new lid mortise, reverse the lid mount and drill two holes for a screw. The larger diameter must be larger than the screw head. Suggest two times the head diameter. Drill this hole about 0.75" deeper than the end of the octagon. (Excludes the mounting tenon size)

Also turn the slanted side of the octagon.

Body:

Mount the body using the end tenon. Fit the tenon to the lid mortise.

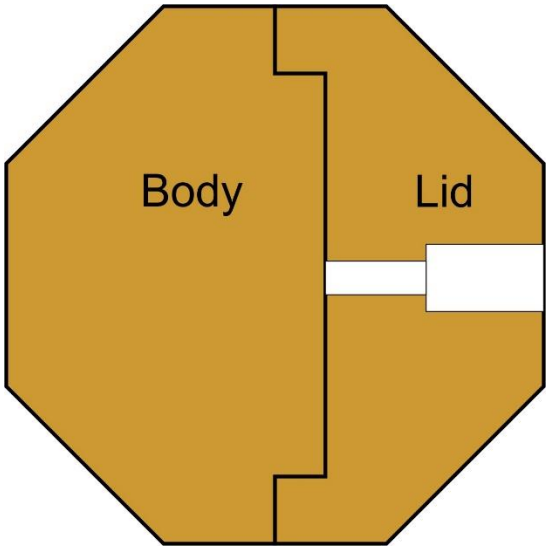
Test:

Ensure the joint mortise can also serve as a mounting tenon.

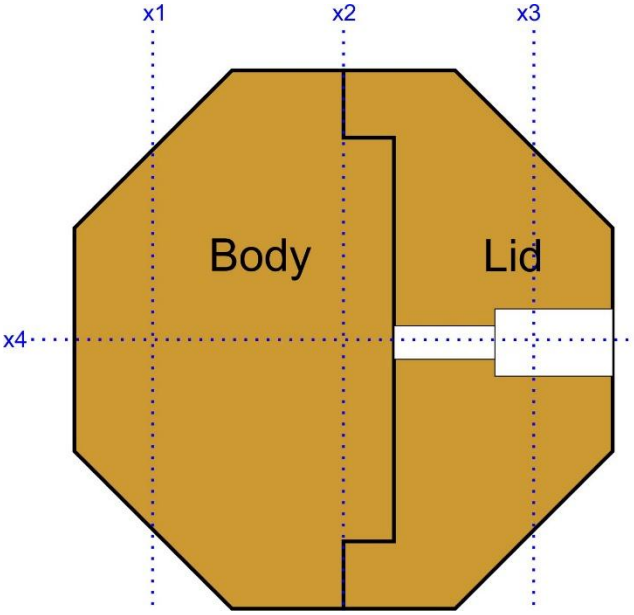
Test the fit and ensure select a screw that will hold the two pieces together. Drill a pilot hole for the screw.

DO NOT hollow the body at this point like in other box making. We need the body mass and strength to withstand the pressures from the multi-axis shaping coming later.

Once tested, the outer tenons can be turned off.

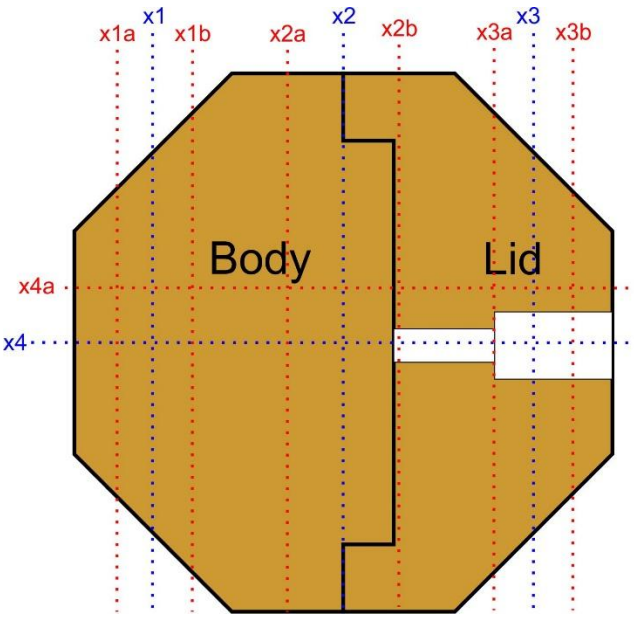


Step 4 – Round (rough) the body and lid



Turning a Multi-Axis Pumpkin Box

To facilitate rounding off the octagon to become a rough sphere, mark pencil lines at x1 and x3. Each is half of the corresponding side. If the joint is at x2, no additional mark is needed. Theoretically, we should mark x4. However, this is the turning axis and not accessible.

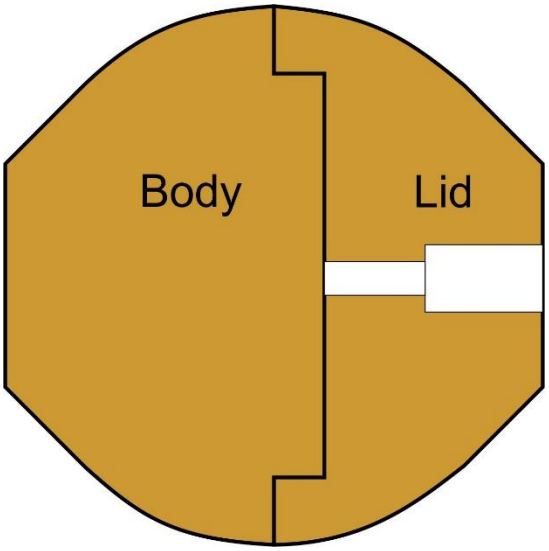


Continue by splitting each surface in half again: Marks x1a, x1b, x2a, x3b, and x4a. Mark both ends of x4a(right and left sides of the octagon.

Cut off each corner with a straight line: x1a to x4a; x1b to x2a; x2b to x3a;x3b to x4a(opposite end) This is now a decahexagon but still contains the sphere.

By eye, round off the hexagon to a rough sphere. Do not overcut. Do not strive for a perfect sphere at this time. When in doubt stop rounding.

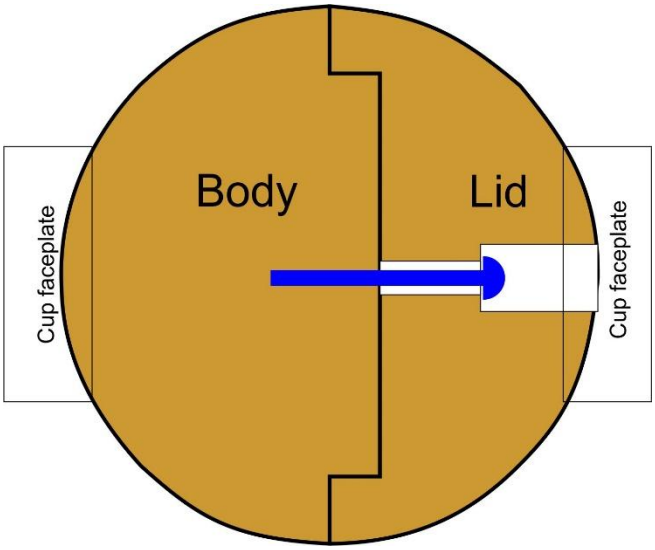
In order to refine our octagon into a sphere, we need to use the cup faceplates process from the sphere instructions. However, our current octagon will not seat well into our cup faceplates. We need to round off the accessible portion of the octagon in order that the sphere will seat into the cup faceplates. The process will then round off the other points as we do the standard rotations to refine the sphere. Refer to the sphere instructions where the decahexagon is formed. This is an adaptation of that section



Step 5 – Attach the pumpkin lid to the pumpkin body.

Screw through the larger holes in the lid into the body. Check again that the head of the screw is at least 0.5 inch below the surface.

Step 6 – Perfect the octagon into a perfect sphere.



Use the cup faceplate process from the sphere handout to perfect the sphere.

Mount the cup faceplates to the headstock and tailstock. (There are alternatives for the tail stock).

Envision an equator line around our assembly.

Rotate the sphere in the cup faceplates so that this equator line now runs north and south. The rounded surface should seat into the cup faceplates.

Gently smooth off the corners as in the sphere handout. The difference is that the octagon corners are still apparent. At this point, these corners are being cut off.

Assess the roundness of the sphere surface. Continue when it looks good. But not perfect – that comes in just a little bit more. Over-cutting at this point is the biggest risk.

Mark a new equator line while the sphere is between the cup faceplates.

Rotate the sphere again so that this new equator line is running north and south.

Again, gently smooth off any roughness.

If the sphere is still too rough, repeat with another rotation. Yet over-cutting at this point is the biggest risk.

As in the sphere instructions in the cup faceplate process, continue with 3 rotations with 80 grit sandpaper and 3 rotations with 120 grit sandpaper.

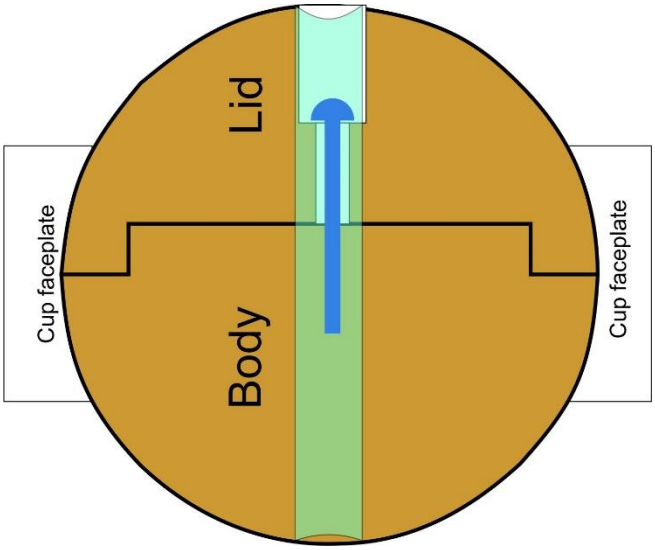
However, do not sand the sphere any further as in the cup faceplate process. It is not necessary for the pumpkin due to the next part of this process.

Step 7 – Mark the pumpkin's unique ribs.

Remount the pumpkin sphere between the faceplates using the original turning axis with an indexing mechanism appropriate for your lathe.

Using the lathe or chuck's indexing capability (or another alternative), mark lines around the pumpkin. Eight lines for a smaller pumpkin or a larger even number for a larger pumpkin.

Step 8 – Transform the sphere into a pumpkin

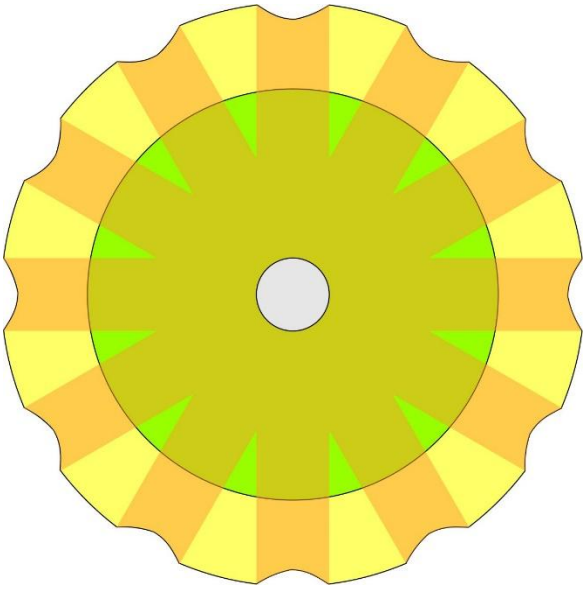


Mount between the cup faceplates. Using two opposite dividing lines and the top screw hole, align the sphere. Use a pencil or other pointing object to follow the line to ensure alignment.

Cut a shallow profile to represent the pumpkin groove or rib. Do not hit the screw.

Sand this profile through the grits (120 grit) to a finishing grit (like 400 grit). Depending you're your desired finish, you may apply it now to the groove.

Step 9 – Complete the pumpkin



Repeat the last step for each dividing line. The above illustration is for 12 grooves. Smaller pumpkins only need 8 grooves.

Step 10 – Complete the pumpkin box lid

Disassemble the pumpkin lid from the pumpkin body.

Complete the lid portion to taste by mounting the lid with an expansion mount to the mortise on the underside of the lid. Drill a mortise suitable to accept a separate stem.

Using this new mortise, reverse mount and refine the underside of the lid.

Add a carved stem using the old screw hole.

Step 11 – Hollow and refine the pumpkin body.

For Interior:

Mount the pumpkin base using its joint tenon.

Drill a shallow mounting mortise on the bottom side.

Using this mounting mortise, drill out the interior of the base.

Alternatively, other techniques can be used to hollow the base. However, the mount specified is not sufficiently robust for any side or lateral pressure. Additional measures will be required for other hollowing techniques.

Be careful. Due to the classic pumpkin grooves and ribs, the walls may not be as thick as perceived.

A doughnut chuck could also be utilized for hollowing.

For Exterior:

A slight hollowing of the base may be required for the box to sit well. To accomplish this, mount with an expansion mount to a chuck and tool the base slightly.

Step 12 – Sand and Finish

Sand any burn marks and any remaining scratches. Apply finish.

At last-

Et Voilá. A pumpkin box. A jack o ’lantern is optional