Using Shell Designer

Shell Designer is a program for creating radial patterns for wood seashell models. This guide will help you use the program to make the shells you design. Shell designer has several built-in models you can use or you can modify them as a starting point to change however you like. . You may use the patterns to make shells for sale or personal use, but you may not sell or distribute patterns. If you'd like to make shells that have a pattern larger than what will fit on 8.5" x 11" paper you may enlarge the patterns.

Parameters

Curve Factor - This variable controls the radial growth rate of a spiral curve. A value of 0 will have no spiralling effect and will result in a circle instead. A value of 1 will result in a curve that resembles the curvature of a bivalve, clam, or mussel shell. A value greater than 1 will cause an even flatter curve such as the curvature of a scallop shell. The larger the number, the looser the spiral curve. Conical spiral shells have a curve factor in the range of approximately 0.05 to 0.25. This variable can be found in the parameter menu, and it works best to type a number in the input box rather than moving the slider.

Number of wedges - This variable is simply the number of segments or wedges it takes to make 360 degrees, and it should be an even number in order to have a flat 180 degree joint across a diameter to make two halves. Machining the half shell joints flat is how any error is removed from the wedge angles. A smaller number of wedges will cause the individual wedges to be thicker, stronger, and less likely to bend or warp. It also speeds up construction and uses less glue. A higher segment count is useful for larger diameter shells such as ammonites or using wood that's not thick enough to make wedges the size you need. Simply type in the number of wedges, and the program will draw the patterns for whatever number you specify. Patterns are made one pattern per page.

Inside and outside points - There are 16 points each to define the aperture shape for inside and outside walls of a shell. While a thin shell wall is more attractive than a thick one, you should apply some extra thickness to compensate for misalignments, make segments stronger and less fragile to handle, and the curvature of a shell. Far easier to make wood thinner than to thicken it. Keep all of the points on one side of the axis, the program will not handle points on the opposite side correctly. Shells can be mind-bending enough with all the points on the same side. The program will draw spirals whether the axis is crossed or not. There are separate checkboxes for inside and outside points in the Shape menu. The line defining the shape should extend farther down than the top of the base in order to define the shape of the columella, especially near the bottom. Check the box for bottom guide in the Shape menu - the shape should extend all the way down to this line so the shell surface makes one complete turn at the bottom of the shell where the cylindrical base starts, and all segments will reach the base where they will be cut off making all segments the same length. Keep the points in order to avoid making loops.Turn off the points that aren't being moved to select desired point more easily.

Left or Right orientation - Like people, most shells are right oriented, but there is a small percentage that are left oriented such as lightning whelks. The program has check boxes for both. Left and right are the same as top and bottom for bivalve shells. Threaded fasteners such as wood screws or bolts are usually right oriented, but left oriented does exist such as turnbuckles or retainer bolts on a shaft.

Scaling a pattern to desired size. The background grid in the 2D window is approximately one inch or 25mm squares. This grid does not show when producing a pattern, and is only for approximate length or width measurements. Use the scroll wheel of your mouse to zoom in or out, or use the fine zoom buttons. Use a ruler and measure your patterns on a printout to verify the patterns will fit on your wedges. Segment 0 will not be used in the construction, use segment number 1 as the largest segment that will determine dimensions of the wedges. All wedges will be the same length making it easier to calculate how much wedge material is needed (Length X number of segments). The program will only export a PDF in 8.5” x 11” size. You may resize your patterns with whatever method works for you.

Glue-on vs. toner transfer. I learned the hard way that spray-on adhesive can reduce the penetration of wood glue causing a weak glue joint. For this reason I like to use toner transfer to put the patterns on wood. Toner transfer requires the patterns to be printed with a laser printer. I like laser printers because there are no expensive liquid ink cartridges to dry up. Some toner will separate from paper when it is wetted with acetone (nail polish remover). Acetone applied to a small piece of cotton fabric will very rapidly soak through paper and cause the toner to transfer onto the wood (as a mirror image of course). Using too much acetone will cause smudging. I learned this through trial and error. It’s also helpful to use a fresh bottle of acetone, it will be more effective with the toner transfer. I think this is because it absorbs moisture from the air which weakens it, so keep the cap on when not in use. You can still glue the patterns onto the wood, or even use a layer of painters tape between, but realize that this builds up a little bit of thickness - and the folded pattern bends around a small radius instead of a sharp edge making narrow sections narrower. It won’t hurt to design the narrow parts of a shell a little wider to compensate and then you can carve or sand it down to your liking after the shell is assembled.

Which side is which? Shell segments have a face that is slightly larger than the opposite side after shaping to the lines. The larger face faces the aperture or opening of the shell. Looking at a pattern, the linework of the aperture side will extend farther away from the apex or tip of the shell. The aperture side also extends farther away from the axis, but the difference is too small to differentiate without measuring. The two check boxes in the upper right of a pattern print are used to switch which side is the aperture side of the segments. There are two methods for applying the pattern to the wedge - toner transfer or glue-on, they result in mirror images of each other. It can be a little confusing which box to check, but either of them will work. One way produces bigger steps to knock down during shaping than the other. A shell made with a smaller number of segments will have larger steps to remove.

What is bottom projected to top? Bottom projected to top is exactly what it sounds like. The segments are cut from wedges on a scroll saw with one face of the wedge flat against the scroll saw table. Bottom projected to top lines allow us to see where the blade is cutting in relation to the lines on the bottom face. The linework is projected to the top perpendicular to the saw table, and the program also takes the wedge angle into account. So now that we can see the pattern lines of both surfaces, we must figure out which line to follow with the saw. The answer is simple, for the interior cutouts follow the innermost line, and for the outside follow the outermost line - in some cases the two will cross. The bottom projected to top is a dashed line while the solid lines represent the inner and outer shell wall. The perpendicular projection also means that you can use flat blades or spiral blades. I prefer spiral blades, but I know most other people prefer flat blades for their work. After your segments are cut out you can shape the segments down to the solid lines especially in the interior to make smoothing and sanding easier when you get to that point. The side of the wedge with the dashed lines faces up while sawing.

Aligning segments during glue-up. The segments should always be aligned so the sharp edge of the segments are even and also the top and bottom ends. It helps a lot and is easy enough to do to make all the wedges exactly the same length. Do not try to align segments based on their cut edges, always use the axis along the sharp edge, and the ends.

Wall thickness and detail. I recommend a wall thickness of at least ¼" (6mm), it's much easier to carve away excess thickness than to deal with thin spots or accidentally sanding through. If you're using a very low number of wedges, then add a little more thickness to compensate for loss from curvature. Shells such as lightning whelk often have a groove in the narrow section that runs along the axis. My suggestion is to leave that area solid, and then carve it out later after some or all of the segments have been glued together. Same thing with the tip, leave the tip end as a cylinder and then carve it to shape later. Another option for the tip is to check the box in the Shape menu to turn on the spire angle to make the tip a cone instead of a cylinder for easier shaping later.

Copying a real shell.

It's easy to make the shell model resemble a real (smooth) seashell with these steps:

1. In the Shape menu turn on the 2D Spiral. This spiral is connected to the outside spiral point, so move it to a position away from the axis to enlarge the spiral. Adjust the Curve factor so that the 2D spiral has similar proportions to the spiral of the real shell while looking directly down on the top of the real shell. The 2D spiral should be the same shape as the spiral on the real shell where the whorls join. Also notice the location where the first turn of the real shell intersects a line between the tip and the outermost point of the top spiral defining the width of the aperture. Adjust the Curve factor until the 2D spiral has a similar shape. Shell Sketch doesn't have a 2D spiral, so adjust the 3D window to look down on the top of the shell.

2. In the Shape menu turn on the spire angle. Adjust the point on the spire angle so it is about the same cone angle as the real shell. Turn on the Profile in the shape menu so the opposite outline appears on the other side of the axis. Select the 4th or 5th point from the top of the outer profile, and drag it to the Spire angle line (you can make the profile on either side of the axis, but I usually use the right side). This will establish the part of the aperture that touches the spire angle. The few points between this point and the end will be used to define the shape of the top shoulder with the end point located where the whorls connect.
3. Turn on Pattern Area in the Pattern Generation menu. Move point T along the axis to where the bottom of the shell should be in relation to the profile point on the spiral angle line. Or in other words, estimate the length of the shell proportional to the radius of the widest point on the spire angle line.
4. Shape the aperture with the other points. Turn on the Bottom Guide in the Shape menu. Move the other end of the profile line to the bottom guide near the intersection with the axis. Drag the Base slider to make the base appear, and size it as you like. Use a few points below the base to define the shape of the lower part of the columella. Turn on the Columella assist point to help shape it if needed. The Columella assist point is actually a pair of points the larger of the two can be dragged around. Move this larger point to an easily identifiable point along the profile and you'll see that the other point is at the same point on the opposite side of the shell where the profile is the same shape, but smaller in size..
5. Check either RH or LH to make your shell right or left hand oriented. A spiral curve will appear in the 3D window. Check 3D Style / Color to turn on the drawing controls and click Draw Outside to draw the shell you defined.
6. Any of the variables can be changed at any time. Unfortunately models can not be saved except for 3D images.

Making Wedge Material. Wedges can be made most easily with a table saw or a band saw. I recommend kiln-dried straight-grained wood without any large knots to avoid problems with warping. Make sure the board is nice and straight as well, and without any cupping.. With the construction being segmented with glue joints in a radial orientation it is not unlike segmented woodturning where the angles need to be very precise. I use a method that does not require such an extremely high level of accuracy. You can get the angle set to within perhaps one half degree or so guesstimating and call it good. The program adjusts to use any even number of wedges. An even number is required in order to have two halves which will be corrected to 180 degrees each with a simple table-mounted router.

The two shells I made while testing my program are both made from southern yellow pine 2 X 10 I picked up from Lowes. I selected a board from the center of the trunk so it would have quarter-sawn grain, and the grain orientation wouldn't change as much with each wedge cut from it. Both shells are made with 16 wedges, so 360/16 = 22.5 degree wedge angle. The width of the wedges would be a little over 1.5" if slicing wedges from the edge of the board. I wanted to be able to flip the board end-over-end after each cut to make the cross-section of the wedges an isosceles triangle instead of a right triangle. Right angle wedges would work fine too, but I wanted to set the angle once and leave it there, so the bevel angle I actually used was 22.5 / 2 = 11.25 degrees. My table saw like most uses a worm gear drive to tilt the blade, and I know that it takes exactly 30 turns of the handwheel to go from square to 45 degrees, so 11.25 / 1.5 degrees per turn = 7.5 turns of the hand-wheel. That turned out to be plenty accurate. Adjust the fence so that the saw cuts barely intersect to form a sharp thin edge. If the thin edge is not a sharp edge then you will end up with a hole down along the axis of the shell. Another distinct advantage of using a thicker wedge angle is that the sharp edge is tougher than the thin edge of a thinner wedge angle.

I also came up with a neat little trick to provide a little extra wood on the smallest segment of each half, that would be segments 8 and 16 for a 16 segment shell. Cut the folding pattern along the axis fold, and use just the half with the dashed line work. Move the pattern away from the thin edge of the wedge as close as you can to the opposite edge and still have good coverage. This will make these two segments thicker than the rest, and most of the extra thickness is cut off when the half-shell joints are flattened with a table-mounted router. The shell will end up looking better without thin shims glued in.

Helpful tips.

Keep the inside surface a shape that is easy to smooth. Avoid sharp interior corners and narrow gaps that would be difficult to finish shape or sand.

If using wood glue instead of CA, wrap joints with rubber bands as clamps.

Keep joints as flat as possible while glue dries. A warped joint will need to be sanded flat before gluing.

Use tape hinges when gluing segments into pairs or groups of four. It not only keeps joint aligned, it also keeps glue off your fingers, and joint surfaces that haven’t been glued yet.

After cutting out segments, write segment number on the edge.

Looking at a shell with spire pointing up, a right hand shell has segment numbers increasing counterclockwise

Use a piece of thick plate glass or quartz countertop material as a flat surface for lapping joint surfaces flat. Check local fabrication shops for scrap material.

A drywall nail with point ground off makes a great sanding mandrel for 3/32” collet. Hot glue a small square of abrasive to the head. Or use a roofing nail for ⅛” collet. Leave the sandpaper square to prevent the edge from digging into wood.

Use Scotch “super hold” tape, it sticks to wood better than regular tape.