Chapter Eight

Fabricating the Neck and Pillar

This chapter will discuss lumber selection and various methods for reinforcing the necks.   Then I will outline the process I use to
-saw out the parts, fair the edges
-precisely mark and drill the holes in the neck
-attach the knee block

Lumber selection

With larger harps and higher tensions, lumber selection becomes more critical. The pillar must be able to resist the torque of the strings twisting the neck.   The Neck will be cut into a curve and peppered with holes for the tuning and bridge pins and cannot crack under load.

If the harp has more than 800-900 lbs of tension I will be choosier about the wood I use to ensure the longevity of the instrument.   I like to make the neck and pillar from a wood that is at least as hard and stiff as Cherry.

Strength and hardness of several species used for the neck and pillar

Specie	Modulus of Elasticity (Mpa)	Side Hardness (N)
Bubinga	17,100	12,000
Greenheart	17,000	8,400
Sugar Maple	12,600	6,400
White Oak	12,300	6,000
Black Cherry	10,300	4,200
H. Mahogany	10,300	3,600
Black Walnut	9,800	4,000

From *Wood handbook--Wood as an engineering material*., Chapter 4, Mechanical Properties of Wood, General Technical Report, FPL-GTR-113 from the U.S. Forest Product Laboratory, 1999

The local DIY home center sells maple, but it is commonly a soft red maple.   It is not as suitable as Sugar maple or the other hard maples.   When you go to purchase wood, you may want to bring a copy of the tables from chapter 4 from the *Wood handbook* (available for free on the internet).   Don't be bashful about asking questions.   If they can't answer them, the wood may be a softer inferior species.

I will build harps from Mahogany or Walnut if the client requests it, but modifications have to be made to the design - thicker parts, reinforcing around pin holes. I still fret about the longevity of the instrument.

I live near Washington D.C. and am fortunate to have a number of well stocked lumberyards within a two hour drive. The best ones will stock 40-50 types of wood, rough sawn in 4/4, 6/4 and 8/4 thicknesses.

Lumbering Semantic
In North America, “8/4” is a nominal size for lumber. Logs are cut into planks 2” thick. After the plank has dried and been planed smooth, it will be 1.5-1.7 inches thick. Smaller harps can be made from 6/4 stock. If the harp is going to be more than 30 strings I get 8/4 stock.

The width of the plank required will depend on the design, and I will often take a plywood template of the neck and pillar to allow me to arrange parts on the plank.

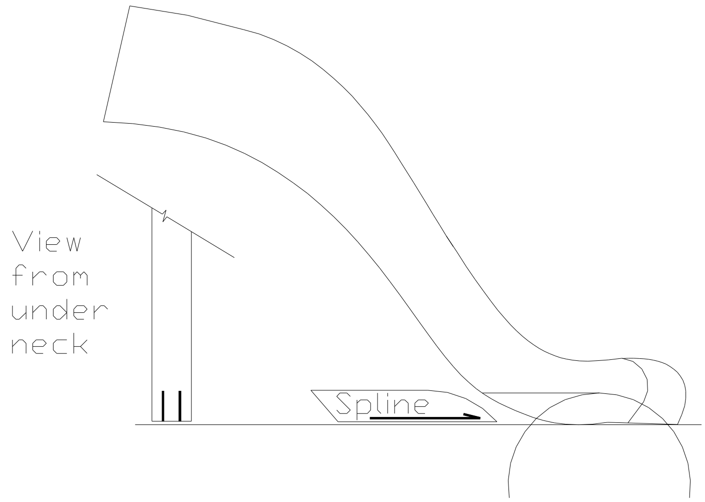
If you have trouble finding the right kind of lumber, you may have to laminate two or three layers of thinner stock to get the thickness specified in the design.

Reinforce the Neck
When necks break, the fracture usually starts on the underside of the neck near the treble end. I have found three effective strategies to prevent the neck from breaking. If the harp has a strong harmonic curve, or more than 400-500 lbs of tension, I use one or more of these techniques to preserve its integrity.

The neck is in tension along the bottom, the neck is usually narrow at the treble end, and cracks start there on the short grain, usually near a pin or screw hole.

Reinforcing with Splines
Slots can be cut into the underside of the neck, using a router or table saw and splines are glued into place. This effectively turns the underside of the neck into plywood which prevents the stress crack from forming there. Because the slot for the spline usually extends up into the area where the bridge pin holes are to

be drilled, I usually put the splines into place after the blank is cut out, but before the pin holes are drilled if the knee block is attached.



To cut the first slot for the splines, I crank the blade on the table saw so it extends 1½" above the table. I set the rip fenced on the table saw so it is ¼" from the blade and run the neck along the fence, stopping short of the knee front corner. I shift the fence about an inch over and cut the second slot.

I cut the splines out of hard maple with a zero clearance insert on the blade and the grain of the spline runs along its length. The spline should slide in easily but not be too loose. One end of both splines is cut to an arc that matches the slot made by the blade. I slather the splines and slots with epoxy and push them into place.

Necks with a strong curve or arch at the treble end for the player's thumb will preclude cutting spline slots on a table saw. Splines can be cut with a router bit and slot cutter, but it is more tedious to fabricate the spline and most slot cutters will only cut ½" deep.

Reinforcing with a Carbon Fiber patch

This is usually done after the neck and pillar have been glued together, and they have been fitted to the sound box. I clamp the neck and pillar upside down in a vice, and cover the sides of the neck with masking tape which makes epoxy clean up easier. Carbon fiber usually comes in rolls that are 6" wide. I prefer unidirectional tape, but have not had any failures with woven tape. I cut a strip that is as wide as the neck, and long enough to cover the short grain running out – usually 6-12".

I mix a small batch of epoxy (15-30ml), and paint the wood with epoxy then apply the Carbon fiber. I spread just enough epoxy on top of the patch to ensure that the patch is wetted out. Two tips to make it a neater job ; Excess epoxy can puddle and creates a more uneven surface, so remove excess pools. Second, the less I mess with the cut edges of the tape, the neater the job will be.

At one time I covered carbon fiber with a piece of veneer to hide it. I found the patch is in a pretty inconspicuous place, and no one noticed it unless I pointed it out, so I rarely try to cover it up now.

The bottom of a neck that has been reinforced with a Carbon Fiber patch.

After about 2-3 hours the epoxy will gel, and I remove the masking tape from the sides of the neck. After the epoxy has cured for 8 hours or more I will scrape the patch so it is smooth, rounding the corners.

Laminate the neck

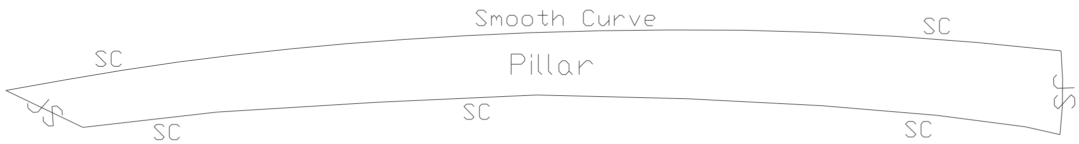
Most builders recommend skewing the grain from one layer to the next by at least 15 degrees. Even when I used a sizeable collection of wood hand screws and C clamps, it proved surprisingly difficult to keep everything aligned and to generate nice tight glue line across the entire surface of the neck. I built five or six harps with triple laminated necks, and none them have required subsequent repair work.

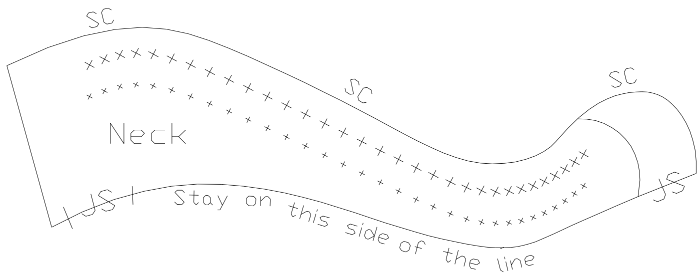
I prefer to use splines or carbon fiber on solid timber because it is quicker and looks better to me without the glue lines.

Another alternative is to use piano pin block material for the neck. Do not use fir core plywood. I tried this on three harps and each eventually split along the soft fir core. I've seen some Paraguayan harps made from birch aircraft ply (with thin, 1mm laminations), but these harps were strung lightly with only 700-800 lbs of tension.

<u>Saw Out the Parts, Fair the Edges</u>

I mark the outline of the neck and pillar from full sized plywood or paper templates clamped onto the lumber. As I cut that line on the band saw, I pay close attention to each line and how accurately it needs to be cut:

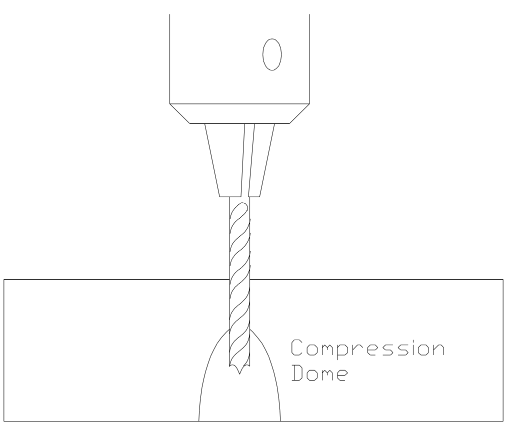




Joining surfaces (JS) mate the neck, pillar and sound box to each other and need to be cut accurately – go slow.
Bottom of the neck – stay outside the line to ensure you will have space to mount the levers
Sides of the pillar, top of Neck should be smooth fair curves (SC) - I focus on making a cut that does not have unnecessary bumps or wavering.

After the pillar and neck have been cut to shape, I smooth the outside curves with a hand plane. The inside curves are trickier. I can usually do the pillar with a short smoothing plane at a skew angle, but the sharper curves on the neck are done with a spokeshave or sanding drums.

Areas NOT so smooth - I refrain from smoothing the joining surfaces till it is time to assemble the parts together. These need to stay accurate, square and true. If the neck and pillar are to be fitted to a stave back or round back sound box, I don't smooth the area near the knee block. This will be ground to shape then they are fitted to the sound box.

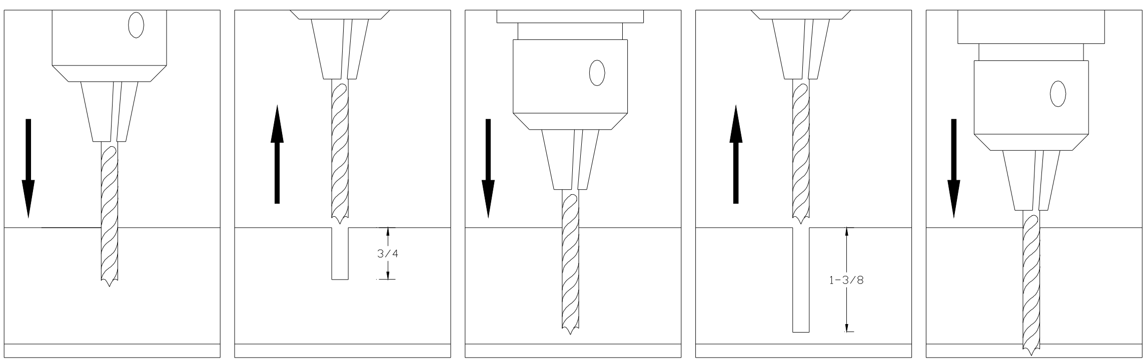


Precisely Mark and Drill the Holes in the Neck

One of the hallmarks of a well built harp are the two rows of precisely placed pins in the neck. My first three harps worked well enough, but I was not able to replicate the clean precision I saw on many commercially made harps. Convinced the makers were using a special bit, I asked Mark Hillman, a finicky machinist and bagpiper maker what he thought they could be using. He explained that many amateurs cannot drill straight holes because they overload the bit, especially in the hard woods frequently used for harp necks.

As the operator pulls the hand feed lever down and the bit enters the stock, a dome of compression forms around the drill tip, increasing the likelihood that the bit will bend and wander. If an overloaded bit is about to pass through the other side of the neck, it will burst through, tearing large splinters from the edges of the hole.

Most harp builders strongly recommend a drill press, mainly to ensure the holes are perpendicular. Two other advantages are equally important. A drill press provides precise depth control and controlled feed rates. A careful operator will prevent the bit from becoming overloaded, frequently lifting the drill bit or reamer out to clear the chips. The result is a clean straight hole. My fourth harp neck looked as clean as any commercially made harp. Here is how I do it:



Drill the hole in a series of plunges clearing the chips from the flutes each time.

During the first plunge, the bit does not have to lift the chips too far out of the hole. Subsequent plunges have to be shorter. Really hard woods may take 5 plunge/retract cycles. The key is to realize when the chips are no longer being lifted from the tip of the bit. If the final plunge is only removing the last few millimeters of wood, you will not get much tear out.

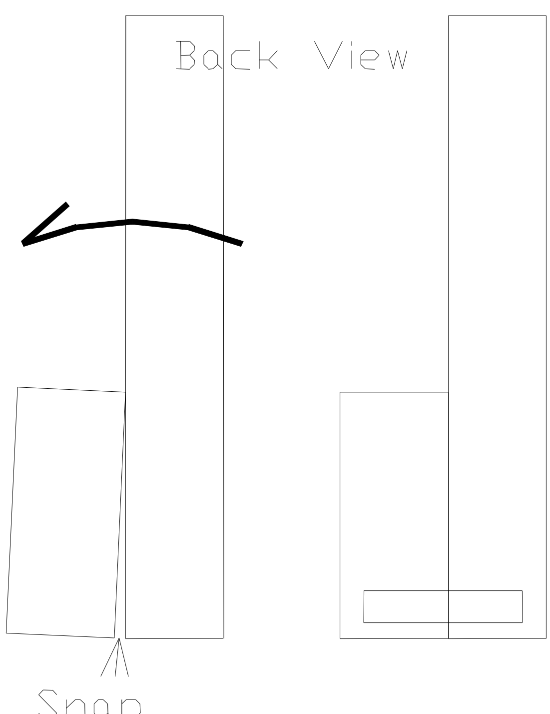
It takes me about two hours to drill the holes for the bridge pins and tuning pins for a five octave harp. It is helpful to have the tuning and bridge pins you will be using in hand. That way you can be sure you are using the proper sized bit and drilling or reaming to the proper depth.

First, I drill the holes for the bridge pins. I set the depth stop so that ¼"of the bridge pin head will remain above the surface of the neck. I find I can get a nice clean hole (with no tear out) if I drop the bit *very slowly* into the work for the first 1/8" or so.

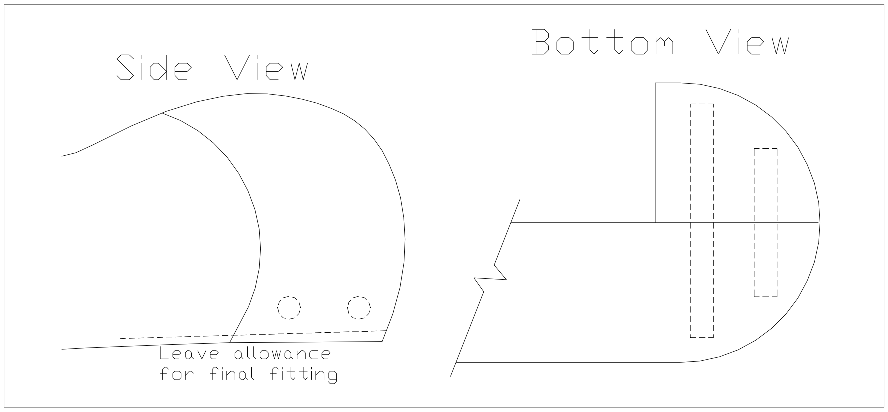
<pic showing neck with bridge pins and tuning pins inserted>
The final bridge pin height is usually set with a block to work with the harp levers. Depending on the hardness of the wood, the tuning pin will move up to ¼" deeper as the harp is brought up to tension. As the hole wears over the years, the pin will move farther into the hole, so I tend to ream just enough to allow the strings to wrap nicely below the hole, leaving room for wear down the road.

Next, I drill the holes for the tuning pins through the neck using a 3/16" bit. Each hole may take 3-5 plunge/retract cycles on a full sized harp neck that is 1¾" thick . Before I ream the holes, I *flip the neck over*. If you find yourself reaming a neck on the same side that you can see the bridge pins, you have made a mistake. I ream all the holes with a #4 reamer, setting the depth stop so the tip of the reamer barely penetrates the neck. Here too, you want to watch to make sure that you are not jamming the flutes full of shavings. I usually cycle the reamer two or three times into the same hole. Reaming goes a lot faster than drilling the initial hole because I don't have to stop the spindle to clear flutes clogged with shavings. Finally, I ream the holes on the bass end with the larger #5 reamer. I usually use a #5 reamer with any wire core strings and nylon strings that are greater than .050 in diameter. Again, I set the depth stop on the drill press so the tip of the reamer barely penetrates the neck.

<u>Attach the Knee Block</u>
Most harps have some kind of knee block that helps resist the torque of the strings. These are usually glued into place after all the holes have been drilled in the neck for the pins. Most of the carving and shaping is done before the block is permanently attached.



I had to repair one or two knee blocks that had popped off when the harp was dropped or banged, so I usually reinforce this joint using one of two methods. You can reinforce the joint with two 3/8" dowels in the joint. If the harp is a round back, the dowel on the back of the joint (nearer the player) is cut shorter. I usually make a blind dowel joint (one where the dowel will not show once the neck and knee block are glued together) using centerpoints to mark the location for the holes to be drilled in the second piece of wood.   The other method is to laminate a fiberglass or carbon fiber patch on the underside of the neck after it has been trimmed to fit the top of the sound box. It is quicker to do than the blind dowels and can be done concurrently with a reinforcement on the underside of the neck.



Placement of the dowels to reinforce the knee block