Building A Steel Guitar

By: John Tipka

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It is not too difficult to build a steel guitar. Probably the hardest thing to do is to apply a nitrocellulose lacquered finish on the guitar. A number of years ago I wrote a brochure for The Hawaiian Steel Guitar Association (HSGA) on how to build a lap style steel guitar. It broke the construction process down into a little more than fifty (50) separate steps. I have prepared a similar, but not detailed, suggested set of instructions that can be used to build single and double neck guitars.

If you have bandsaw, a drill press and bits, and a router, it will make the job of building the guitar very easy. You can use almost any type of hardwood for the body of the guitar. I have built guitars with ash, maple, white oak, alder, mahogany, poplar, basswood, and even one using the "relatively hard" softwood - yellow pine.

I like to use poplar for a guitar with an opaque finish and ash for clear finishes.

My Reasons:

- Both can be found in three-foot lengths that are clear (no knots or checks).
- Both are of medium density and mill and machine easily.
- Both are fairly close pored and don't require a lot of filling.
- Both can be found in widths of 9 to 14 inches and thicknesses of 2 to 4 inches.
- Both are inexpensive - from ~$1.95 to $3.00/board foot - at least, in the Old Order Amish lumber yards in eastern Ohio.
- Both seem to be resonant, especially when the strings go through the body of the guitar.

Decisions

- Decide what kind of guitar you want to build: one that is played on your lap, or a console model on legs.
- How many strings? Six or eight? - This decision impacts the type of machine heads and magnetic pickup to be used.
- What kind of pickup? Bar or pole piece - If pole piece pickup is used, it will determine the guitar's string spacing.
- And finally, the scale length - (this is the distance between the nut and the bridge, generally 22 to 25 inches.) Shorter distances provide easier playing and less string tension.

Templates

- Make templates for every cutting, boring, or routing operation performed on the body. This includes body shape, holes in headstock for machine heads, pickup cavity, volume/tone controls cavity, fretboard layout, etc.
- Insure symmetry of the *body shape*. It is best to draw the curves on poster board for only one-half of the body along the longitudinal axis and then fold the poster board along that axis and cut the curves described. The shape is easily transferred to the raw stock using the template.

Component Parts

- Have all parts on hand before construction;
- Changes may be needed to accommodate the design of the parts.
- You will probably have to fabricate the parts you can't purchase (nut, bridge, fretboard). You should be able to buy everything else.
- And, use one of the *free* fret distance calculator tools that are available on the Internet for the design of your fretboard.;

Species of Wood

In my experience in building more than twenty-five steel guitars out of wood, I have found the following characteristics about the different species of wood used to build them. Using the same model of pickup on each of them, with all other things being equal: *Honduras mahogany* - a Gibson EH-150 full, mellow midrange to slightly bass sound; *white oak* - a smoother midrange to bright Fender *Stringmaster*® sound; curly or *bird's-eye maple* - a brighter sound than the Fender sound; *American Southern yellow pine* - a sharp, biting bright sound.

These woods range from porous to dense and vibrate at different frequencies than each of the others. That is the reason for the differences in sound. It's your choice, and of course, that depends on the type of finish to be used and what is available to you.

Grain and Color

If you want to see the grain and color of the wood, then probably a clear (transparent) nitrocellulose lacquer is best be used. This will require a clear (free from blemishes and imperfections) piece of wood for the body. Water-based and alcohol-based dyes are available to make the body any color you want. The lacquer also can be tinted to almost any color desired. The instruction and blueprint are for a lap-style steel guitar, not a table or console-type with legs.

Before you start, you'll need to make two decisions:

(1) Scale length for guitar: short (22->23 in) or long (24-1/2->25 in); 571.5 mm-> or 622 mm->
(2) Number of strings

Parts you'll need to purchase to complete the guitar:

(1) Tuning machines (Grover, Kluson, three or four-in-line)
(2) Magnetic pickup for number of strings on guitar
(3) One (1) 250,000 ohm audio taper potentiometer
(4) One (1) 250,000 ohm linear taper potentiometer
(5) One (1) .047 microfarad tone capacitor
(6) One (1) open circuit jack for 1/4 inch plug

For a steel guitar player "building your own" can be a very rewarding experience, and you certainly "learn" your instrument along the way.

STEPS:

1 - **Make the nut** - This piece can be made from bone, ivory, Micarta©, aluminum, etc. Score or cut each of the string grooves with a thin edge cut file. Locate the two outside strings 1/8 inch from each end of the nut. The remaining four or six strings are spaced equally between the two outside strings.

2 - **Make the bridge/tailpiece** - If using a tailpiece, bore the string holes in the rear leg of the tailpiece to match the spacing of the pole magnets in your pickup. The two outside strings are spaced 1/8 inch from either end of the tailpiece. And, as with the nut in step 1 above, the remaining four or six strings are spaced equally between the two outside strings and should match the magnets in the pickup. The string holes have varying sizes to accommodate the diameter of the treble and bass strings.

If using holes-through-the body technique, cut the string grooves on the round bar stock on a lathe, cut the bridge to length, and finish the end surfaces. Center on the diameter, and bore and counterbore the two holes on each end used to anchor the bridge to the body. Again, string grooves are spaced to match the spacing of the pole magnets in the pickup.

3 - **Layout and cut a template for the guitar body** - Layout the body shape of your guitar on a piece of 1/4 inch (6mm) thick plywood. If you make a traditional shaped guitar, make sure you maintain symmetry on each of the bouts. Use a heavy piece of paper large enough to be folded in half along its length and layout half of the guitar along the longitudinal axis. Fold the paper exactly in half along the longitudinal center line. With scissors, cut along the lines you drew for half of the guitar. When you unfold the paper, you have a perfectly symmetrical template for the guitar body. Lay the paper on the plywood and trace the shape onto it. Cut out the plywood template using a coping, jig or band-saw.

4 - **Layout locations of tuning machines, pickup, cavity for volume/tone controls, and output jack on the wooden template.**

5 - **Bore proper diameter holes** accurately in the template for the tuning machines.

6 - **Locate and mark position of bridge/tailpiece**. From front face of bridge/tailpiece or from center of round bridge, measure the scale length distance down the neck of the template. This dimension is the location of the nut. Will the nut be in the proper location with respect to the tuning machines? If not, move the location of the bridge/tailpiece more to the right end of the guitar until the nut will be properly placed.

7 - **Double check all locations and measurements on the template.**

8 - **On the template, bore or cut out the marked locations** of the pickup and the volume/tone control cavity

9 - **Trace the body shape from the template to the blank wood stock.** The guitar blank must be at least 1-1/2 inches thick (40 mm).

10 - **Cut out the body with a band saw**. With the guitar blank on its edge, cut the thickness of the headstock first, making sure of parallelism. Second, and with the blank on its edge, cut the bottom taper of the neck. Lastly, cut the outline of the guitar, i.e. both bouts, the neck, and the headstock.

11 - **Sand the body** with increasingly finer grades of sandpaper, e.g. 100, 150, 220, 320, until almost glassy smooth. **Nota Bene (N.B.):** ***Garnet sandpaper works extremely well here because of its low frangibility, sharp edges, and fast cutting speed.***

12 - **Fit the template to the guitar body and mark the locations** of the tuning machines, nut, pickup, volume/tone control cavity, and bridge/tailpiece on the guitar body. Mark the longitudinal centerline of the guitar.

13 - **Rout the pickup cavity**. Since the height of pickups varies, the pickup cavity should be routed only deep enough so that the top of the pickup poles will normally be 4-6 mm below the bottom of the strings. If height adjustment screws are available on each end of the pickup, then the cavity may be routed an additional amount equal to the length of each adjustment screw's shank. The bottom of the strings is determined by the height of the forward leg of the tailpiece or the diameter of the round bridge (typically, 13 mm =1/2") with the top of the guitar as the datum line. Pickup orientation is your choice. It can be perpendicular to the guitar's centerline or at a slant to the centerline. Generally, slanting is from top to right and bottom to left. But remember, if you slant the pickup, then you narrow the string spacing. Standard pickup string spacing is 9.5 mm or 3/8".

14 - **Rout or bore the volume/tone control cavity** only deep enough so that one or two threads can be seen above the shaft nut of the potentiometers when they are installed on the cover bezel.

15 - **Rout or cut a groove for the nut** so that the top 13mm or 1/2" of the nut is above the top of the fretboard. This groove MUST BE EXACTLY PERPENDICULAR to the centerline of the guitar.

16 - **Drill a 32mm or 1-1/8" diameter hole for the output jack** wherever you want it to be in

the rear (large) bout of the guitar and deep enough to accept the length of the jack when a plug is inserted into it. Make sure the hole is centered with the thickness of the body. **N.B**.: ***The wires to the output jack must be able to connect to the volume/tone control cavity AND the pickup cavity.***

17 - **Drill the six or eight holes for the tuning machines PERPENDICULAR** TO THE TOP and BOTTOM SURFACE of the angled headstock. **N.B.:** ***You only have only one c*hance, and no others, to get the holes correct before you drill. You have ruined your guitar body if the shafts of the three- and four-in-line tuning machines will not line up and fit into the holes you drilled into the headstock. When you are using in-line assembly tuning machines, make sure they fit PERFECTLY into the holes drilled in the template and you accurately transfer their location to the guitar's headstock. Not only must the holes for the tuner shafts be the correct distance apart, they must also be drilled perpendicular to the faces of the headstock or else the saddle of the in-line assembly will not seat against the headstock's face.***

18 - **Mount the tuning machines on the headstock** with the small screws provided.

19 - **Install the nut in its groove**. The groove should be tight to prevent the nut from moving endwise.

20 - **Install the bridge/tailpiece in its location**. Carefully recheck your measurements between the nut and the center of the forward edge of the bridge/tailpiece before boring any holes or inserting any screws.

21 - **Fit three or four treble strings on the guitar** and tighten to any pitch.

22 - **Accurately mark on the guitar neck** the probable location of the TWELFTH (one-half of the scale length) and TWENTY-FOURTH (three-fourths of the scale length) frets.

23 - **Avoiding parallax, do a finger harmonic** on each of the strings over frets twelve (12) and twenty-four (24). Did the harmonic occur exactly over each of the two marked fret positions? If it did then intonation on the guitar is very good. If not, the bridge/tailpiece may be slanted left or right of perpendicular with the guitar's centerline. Per chance, may you measured incorrectly and may have to plug the bridge/tailpiece anchor screw holes and relocate them. Cosmetically, unless there was a major measurement error, the guitar shouldn't be impacted since any plugged holes will be under the bridge/tailpiece. The other option is to make the guitar's fretboard conform to the error by shortening or lengthening each fret. However, I consider the fretboard as only a guide to get you into "the neighborhood" with the rest left to your ears. If the error is minor, compensate for it with your bar hand.

24 - **Unstring the guitar and place the pickup in its cavity.**

25 - **Mount all of the strings on the guitar** and tighten them to any pitch.

26 - **Check to see that the strings bisect the centers** of the top of each of the pole pieces in the pickup. Align the pickup accordingly.

27 - **Check the pickup for distance under the strings.** I use the thickness of an American quarter-dollar as a gauge for this measurement.

28 - **Put some alignment marks (----> <----) on both the pickup and the guitar body.** A piece of masking tape used for painting stuck onto the pickup is good for this.

29 - **Unstring the guitar**.

30 - **Remove the pickup from its cavity.**

31 - **Check the fit of the volume and tone controls in their cavity.**

32 - **Design and make a bezel** to fit around the pickups and to anchor the volume and tone control potentiometers. Three (3) millimeter thick (1/8") Plexiglas spray-painted on one side is a good choice here. The spray-painted side then is mounted down preventing the paint from becoming marred or scratched.

33 - **Check the fit of the bezel** on the body of the guitar. Mark the location of the control shafts for the volume and tone control potentiometers on the bezel. Bore 10mm (3/8") potentiometer mounting holes in the bezel.

34 - **Place the pickup back into its cavity** in line with the marks in step 28 above.

35 - **Mount the volume and tone controls on the bezel**. Place the bezel on top of the pickup so that the volume and tone controls fit into their cavity.

36 - **Mark the outline of the pickup edges on the bezel**. Cut out the pickup hole in the bezel. Bore and countersink mounting holes for #4 oval head wood screws.

37 - **Test fit the bezel over the pickup and the volume and tone controls.**

38 - **If the fit is correct in step 37**, remove the bezel and demount the controls.

39 - **Paint the bottom side of the bezel** with an enamel paint and allow to dry.

40 - **Check the fit of the output jack in its mounting hole**. Make a mounting plate for the jack approximately 40mm (1-1/2") square. Eighteen (18) gauge aluminum is a good choice. Bore a 9.5mm (3/8") diameter hole in the exact center of the square mounting plate. Bore holes in each corner of the mounting plate to attach it to the guitar body.

41 - **Check that there is a path to connect wires between the output jack, volume and tone control, and pickup cavities.**

42 - **Remove the tuning machines, nut, pickup, bridge/tailpiece, volume and tone controls, and bezel.**

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43 - **Finish sanding** with 400, 600, and 1200 grit paper, and if necessary, fill and seal.

44 - **Apply multiple coats of a finish** of your choice. Smooth with pumice and rottenstone and buff and polish, as necessary.

45 - **Remount the tuning machines, nut , and bridge/tailpiece**.

46 - **Mount the pickup in its cavity.** Install **output jack** in its mounting hole. .

47 - **Route wires** from the pickup to the volume/tone control cavity. Route wires from the output jack to the volume/tone control cavity.

48 - **Connect and solder pickup** to volume and tone controls and output jack according to pickup manufacturer's instructions.

49 - **Install output jack mounting plate** over output jack and secure to guitar body with #3 round head screws through holes in each corner of the mounting plate.

50 - **Mount bezel over pickup and controls.** Secure bezel to guitar body with #4 oval head wood screws. Install knobs on the controls.

51 - **Make and mount a fretboard** on the neck of the guitar. Use measurements in the accompanying table to prepare the fret positions. Locate the twelfth (12th) fret on the fretboard with the previous mark from step 22 on the guitar body. Fret zero should be touching the nut.

An easy way to make the fretboard is to use Plexiglas or Lexan for the fretboard. Cut the fretboard to length and width. Prepare a paper template of the fret positions. Place the clear Plexiglas/Lexan fretboard over the paper template. Place 1/16" wide automotive striping tape on the fretboard over each of the fret positions marked on the paper template underneath. Spray-paint a solid color enamel or lacquer over the striping tape. Allow to dry thoroughly. Remove the striping tape to reveal clear unpainted lines in the solid color background. Spray over the clear lines and solid background with a contrasting color. The painted side is mounted against the guitar body. Drill mounting holes and mount to the guitar body with #4 flat head wood screws.