The Big Square Table

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Background

This is a description of the making of the country table for my client's dining room. Wendell and Stephanie favor somewhat rustic, country style furniture and aren't against a reasonably eclectic mix. We discussed building a table more than once along the way and the conversation appeared to be getting pretty sincere in late 2010. I had contacted Stanley Dunn at BRC in McMinnville to be on the lookout for 8/4 Walnut boards for me when we first started discussing the table so when he told me in December that he had some in his shed, I went there in late December to look at them. I ended up purchasing wood for what I believed to be a more or less standard shaped table. The boards were nominally 8 feet long and ranged in width from 7 to 14 inches. I brought the wood to my shop and put it on stickers to let it equilibrate to the inside relative humidity.

I used Sketchup to design a table that I thought met their description.

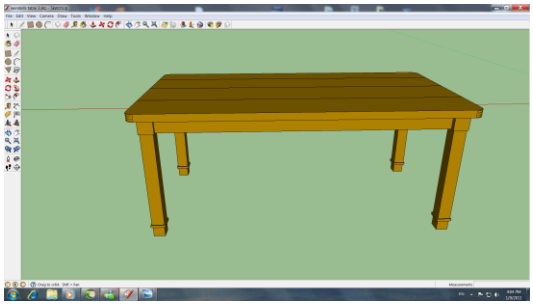

Figure 1 Original Concept in February 2011

The table would be a pretty standard configuration dining table, rectangular with sturdy legs, an apron, and thick table top.

On a trip looking for a chair to replace a recliner about that time, LaDoris and I also looked for inspiration at some tables in the stores. An example is shown here.

Figure 2 Searching for Inspiration in February

Wendell and Stephanie attended a dinner party some time after that and sat at a table that was about 60 inches square. The party was at a friend's home where both husband and wife are architects. They were impressed at how that table enabled a more intimate conversation and dining experience. We started looking into that and by the end of February we were thinking and planning along those lines. The design criteria were for a table with a thick top about 60 inches square with a country look.

Design

The design of the table was done using Google Sketchup. Various schemes were explored to address stability and strength based on the span of the table. Keeping the undercarriage of the table square and stable was one of the primary focus points. The first design used a conventional approach with cross members about 6 inches above floor level.

Figure 3 Concept sketch for 5 foot square table – early March

The cross members – meant to make the table more study – turned out to be a problem since they interfered with seating and chair placement. So the design progressed without them. A conceptual design followed showing a square table without the cross bracing. That left me uncomfortable since the thick tabletop would not be tightly fastened down to the frame to keep it square because of the need for accommodating wood movement due to changes in relative humidity.

Figure 4 Design of Square table with chairs

I decided to put the cross members at the top of the sub-frame to keep the assembly square, effectively making the sub-frame independent of the table top. To permit this placement, the tenons for the aprons were made as large as the thickness of the aprons would allow while still having a set back from the face of the apron to the tenon face. Also, the tenons were made a longer than normal 1 ¼ inches. The cross pieces were attached to the legs in a mortise on the inside corner of the top of the leg. These tenons are also 1 ¼ inch in length and ½ inches thick and are as wide as the cross piece would allow.

Since the cross pieces had to be installed after the aprons were glued to the legs, they required open mortises in the inside corners of the legs. That left an inherently week joint in a place where a strong joint was required so I decided to use epoxy to secure the mortise and tenon.

Figure 5 Design of table structure with cross members.

Deciding on the form of the legs was the next challenge. Almost anything done to adorn the legs – for example: turning or tapering – would take away from the massive look desired for the table.

The decision was to use a chamfering scheme with the corners on the legs but leaving portions square to adorn it somewhat keeping it from looking too plain. Sketches of that still looked plain so fluting was added to the final design.

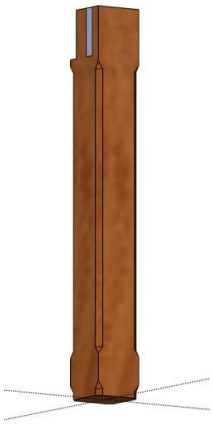

Figure 6 Chamfered leg w/o flutes

Figure 7 Flutes added

Just to make sure of the look of the design and to test the layout for the fluting jig, I made a mock-up of the leg on a walnut board cut to size. I didn't want to practice on an actual leg.

Figure 8 Mock-up of leg

Machining parts for the undercarriage

Chamfering was done on the router table by placing start and stop blocks to ensure that the chamfers were placed correctly; then all four corners of the legs were milled accordingly.

Aligning the flutes correctly required building a fluting jig to guide the router in each milling operation. The jig straddles the leg and puts the router in line to mill the center flute. Then the guides are moved to cut the first side flute after which the jig is turned around so that the second side flute is symmetrical with the first.

The next major step in leg construction was to cut the mortise slots. The apron mortises were straight forward. A ½ inch up cut straight bit was installed in the router table; the fence was placed at the required distance; stop blocks were installed to guide the start and stop positions; a feather board kept the leg from drifting away from the fence; and the leg was depressed onto the bit. Several passes were made for all eight mortises to ensure a clean cut without stress on the router or bit.

Figure 9 Fluting jig. Positioned on the leg and moved from stop block to stop block.

Milling the mortises in the inside corners of each leg – for the cross pieces – required a plywood jig to hold the leg at a 45 degree angle while the cut was made in each leg. Again stop blocks governed the length of the mortise and several passes made to cut the mortises.

Tenons on the aprons were cut using a dado blade in the table saw and a sliding panel. The saw's rip fence was used to ensure that the lengths were consistent.

Once the legs and aprons were milled, they were all sanded and cleaned up ready for assembly.

The legs and aprons were dry assembled and held together with a strap clamp so that exact measurements could be made for the cross pieces. Those were cut from hard maple – tenons put on using the same tenoning technique used on the aprons – and dry fitted into a nearly complete undercarriage assembly.

Figure 10 Undercarriage under construction – July 13

Assembly of the undercarriage

Once everything fit on the undercarriage assembly it was glued together and cleaned up. Titebond 3 was used everywhere with the exception of mortise and tenon joints securing the cross members to the inside corners of the legs. Those joints were secured with epoxy. A gusset made up of 4 triangular pieces was glued and screwed at the junction of the two cross pieces to add to the rigidity of the undercarriage.

Figure 11 Base made except for finishing – August 18

The construction described above involved putting together 14 pieces of wood to make the undercarriage of a large table. It involved pretty standard woodworking techniques and materials.

Finishing the undercarriage assembly

Finishing was started with a thorough sanding down to 220 grit. Then two coats of lacquer sanding sealer were applied to ensure coverage before a thorough sanding with 220 grit again. The surface was then ready for the final lacquer finish. A satin sheen lacquer was used to finish protecting the wood and present a pleasant finish. A thorough rubout with brown shoe polish was done to give the final finish a pleasant feel.

To give time between coats of lacquer and best utilize time, the undercarriage was finished in breaks between working on the table top.

The Table Top

The table top was the real challenge; not the least due to the massive size and weight. Since I couldn't move it without help, planning had to include breaks in the action between visits by strong arms or arranging for help to turn the table over or move it to a new location.

The top of this table is made up of several pieces of 8/4 (2 inch thick) black walnut. The lumber was milled and kiln dried at the supplier after which it was stored in an open air shed; thus, equilibrating to the outside air. It wasn't until the wood was purchased and brought to my shop that it began the process of drying back to something close to residential moisture content. That process required stickering (placing short wood scraps on about 18 inch centers between each board) and allowed to equilibrate to shop relative humidity levels.

The wood was rough cut into 8 foot lengths which offered some flexibility in selecting not only the board but what part of the board was best suitable. Finally a decision was made to cut off the waste from the best 66 inches of each board leaving 3 inches on each end for snipe should it occur during the planing and jointing operations. To see the grain patterns well enough to do that, we skip planed[i] each board before cutting it to length.

Once the boards were thus cut to length, the next natural step was to joint[ii] the edges and plane the surfaces without losing too much thickness. A goal of 1 ½ inches was set and ultimately we were able to achieve that plus a little.

After jointing and ripping a parallel edge on the tablesaw, we used the planer and a sled with wedges to level one side of each board and then flipped the boards and planed the other face parallel to that.

Even at 66 inches an 8/4 walnut board is heavy and awkward to handle. We had significant difficulty getting the edges straight enough to put the boards together without gaps either at the end or along their length. Several attempts to align the jointer did not help the situation and I decided that the problem wasn't the jointer but the person running the boards over the jointer. As a result, several techniques were used to accomplish jointing and joining the boards including using the table saw, a router and straight edge, and finally a loaned set of hand planes called jointer planes.

The next challenge came up once the boards were jointed well enough to glue them into an assembly. Gluing adjacent boards and pulling them together with clamps inevitably affected the non-glued edge; taking out what looked like miniscule deviations from a straight edge resulted in adding deviation to the outside edge of one or both boards. There was no way to pull that out so it was back to jointing those

edges. That was done mostly with the straight edge and router.

The boards were thus glued up in pairs then fours, etc. to get a full 60 inch width. The final glue up required 7 clamps, each of course required to span the 60 inch width. Note that the clamps had to be, more or less, evenly spaced with 4 on top and 3 below to equalize the pressure and minimize cupping the assembly.

Even with all of the precaution of jointing and checking each joint, two boards on one side of the top were angled up. After considering how to fix what could be a major problem, I realized it wouldn't be possible to level the top without cutting those boards loose and re-jointing them. That is easier said than done but a straight edge and circular saw did the job of the cut and several attempts with straight edge and router provided the straight and square edges required to get a final assembly flat enough to work with.

Figure 12 Final glue up of top. Note use of 7 clamps

Remaining work after the table top is glued up was to get the bottom side of the top flat enough to sit level on the undercarriage and to then get the top side flat and finished.

So Henry Davis, a friend and fellow woodworker, came over and helped me flip the top so the bottom side was up. Henry also brought me three planes from his personal hand plane collection to use in the flattening process. That was a real compliment since collectors are understandably careful with their collections. Those planes were really helpful in getting the bottom side of the top as level as it needed to be so that it sits on the undercarriage properly.

Flattening the bottom side involved being sure that I knew where the legs, aprons, and cross members ultimately would interface the top. To do that Henry helped me put the undercarriage on top of the upside down top assembly where I marked the locations of each member with a Sharpie pen. With that done, I went to work flattening the interface being careful to replace any of the outlines removed by the planes as I worked. I moved the undercarriage around on top of the upside down top so it would still be available to make sure that it fit each spot as it was leveled.

Once the leveling was done, I removed the undercarriage and put three coats of polyurethane varnish on the bottom side.[iii]

Wendell then came to Manchester, we flipped the top over so that the top side was exposed and we began the process of leveling the topside. The two of us used the planes to flatten, as much as possible, the topside and sanded with 80 grit 4 x 24 inch belt sander for a bit but it was doing a poor job so we switched to a random orbit sander with 80 grit paper.

After looking at the results the next day, I decided to go back after the top with a #6 plane but first I switched to a Hock blade that I bought for this purpose. I sharpened the blade with a

slight camber on the ends and set the plane to a very fine cut. Then I went over the top one more time to level out local high spots.

It seemed at that point that I'd gone about as far as reason permitted. While there were still some high spots I decided to proceed with sanding using a random orbit sander progressing through the grits.

Figure 13 Sanding with Random Orbit sander

There were several places where the grain was pulled up or there were small blemishes. I made a paste of polyurethane glue and sanding dust from the sander bag, filled the bad spots and left them to dry overnight.

After the patches were dry, I sanding the area around them starting with 150 grit and sanding up to 220 grit. At that point, I sanded with 220 grit sheet paper on a sanding block.

Figure 14 Sheet sanding completed.

Finishing the top

With all the pre-finish sanding done and inspected, I began to apply finish. The finish plan involves using Watco natural oil finish for a first and second coat applied with fine wet/dry sandpaper. The process requires sanding the wet oil until a slurry is achieved and then wiping the excess across the grain to fill the pores with the slurry. The first coat is sanded in with 220 grit paper and the second with 320 grit sandpaper. The first coat is allowed to dry over night and then sanded with 320 grit sandpaper before applying the second coat.

Figure 15 Table top after second round of sanding in Watco oil

With the pores now filled with the slurry created by sanding the oil in, the remaining

finishing involved padding on five coats of polyurethane varnish thinned to a 50/50 mixture with mineral spirits and, after inspection of the finish at that point, I added a sixth coat of 60/40 mixture. All coats were wiped on using a cotton cloth wrapped in a section of panty hose

Figure 16 Table top after application of last coat of polyurethane varnish.

Coat #	Description	Day	Time
1	Watco/220 grit slurry	10/25	0900
2	Watco/330 grit slurry	10/26	0930
3	MinWax/MinSpirit 50%	10/27	0900
4	MinWax/MinSpirit 50%	10/27	1600
5	MinWax/MinSpirit 50%	10/28	1000
6	MinWax/MinSpirit 50%	10/28	1600
7	MinWax/MinSpirit 50%	10/29	0930
8	MinWax/MinSpirit 60%	10/30	1030
9	MinWax/Br Shoe Pol	10/31	1030
10	MinWax	10/31	1100

Table 1 Finishing Schedule

The final steps on the top was a coat of MinWax furniture paste wax mixed with brown shoe polish followed by an application of plain MinWax and buffed out with a automotive buffer.[iv]

Assembling the top to the undercarriage

To hold the table top flat on the table required hold downs that permit wood movement. Fastening the top had to be done with slotted blocks screwed and glued to the apron along the cross grain side of the top. No connection is made to the undercarriage on the long grain sides of the top since that would restrict cross grain expansion and contraction of the top.

The table top is secured at its center with screws through the gussets in the cross pieces. That leaves 30 inches of walnut of various grain orientations to expand and contract as the relative humidity of the environment changes from winter to summer in a naturally cooled home[v]. Thirty inches of Black Walnut could expand and contract over half an inch in the range of relative humidity of 30% winter to 70% summer.

Figure 17 Hold downs for the table top. Screws were centered in the slot and driven into the table top thus allowing movement in the cross grain direction.

Screws are driven into the bottom side of the table top through the slots in the hold downs.

Centering the screw in the slot leaves ample space for expansion and contraction of the top.

Figure 18 Attaching undercarriage to upside down table top.

Wood expands very little over its length, but there is enough space in the slots to permit that movement without damage to either the top of the under carriage.

Delivery went off without a hitch. The heavy top was the primary concern, so I made a carrier for it. The carrier gave a handhold for two people – the top weighs well over 100 pounds but Wendell and I handled it easily.

Figure 19 Carrying the table top to the trailer using the carrier made for this purpose.

Conclusion

The table was a major challenge for me and my small shop. As mentioned, the major problem was the inability to just pick it up and move it. That restricted progress to a great extent. By comparison, the other issues were minimal.

The Google Sketchup design tool was indispensible in this project. Drawing this on paper or using a flat design software program would have been very difficult both due to the unique joinery and the size of the parts.

The undercarriage leaves little in the way of concerns. The strength of the design turned out very well. For something that will get very little exposure given that it's covered by a massive table top, it pleases the woodworker in me both aesthetically and structurally.

The top (spoken in the latest fashion) "Not so much." It just didn't turn out as well as I imagined it would. The difficulty in flattening it resulted in some artifacts in the final finish that can't at this point be changed. My consolation is that the client wished for a country look, and I think that has been accomplished – dings and all.

I think that most woodworkers would tell you that tables are one of the easiest designs to build. Up to this point, I would have agreed, but now I think I'd have to add a caveat or two.

In the end, the table was delivered; the client was happy with it; and we had the first meal – hot pizza and a nice salad.

I enjoyed the experience and I'm really glad that I took it on. I certainly learned a lot doing it – both how to do and how not to do a Big Ole Square Table.

Figure 20 Final Set up

Figure 21 The table in its new home.

[i] Skip planing is just a light pass through the planer to remove some of the rough surface enabling a better view of the grain pattern without changing the thickness very much.
[ii] Joint – woodworking term for making an edge or surface flat and true. Joining boards edge to edge requires that edges the boards are jointed.
[iii] The top will need roughly equal coats of varnish on its top and bottom sides to promote equal moisture exchange and minimize warping. The top side ultimately had about seeveral coats of much thinner polyurethane varnish.
[iv] Wax fills voids. So called natural wax with a buff color will leave that color in voids. Brown shoe polish colors the wax and minimizes that effect.
[v] The McGuirk home is cooled by a whole house fan in the summer and heated by a wood burning fireplace in winter. While the relative humidity is not expected to cover the full range planned for, I decided to err on the safe side and allow for a wider range of movement.