FOUR PIECE ENTERTAINMENT CENTER AND BOOKCASE

Dave Ronyak

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I recently completed, well almost..., a large wall unit/entertainment center and will share details of its design and construction, as well as the problems I encountered along the way, how I addressed them, and my suggestions for anyone who chooses to make a similar project. The entertainment center comprises four separately constructed cases that are fully finished on 3 sides so they can be used together or separately or with other furniture pieces. I say "almost completed" because doors to hide the TV when not in use are still under design considerations and location of suitable veneer and accent wood, and I need to make and install the dividers within the drawers that are behind the glass doors. Most of the major challenges I encountered were due to working alone in a small overcrowded single car garage/shop.

The cases are constructed of double-sided red oak veneered plywood with solid oak edging, most of which was attached using Festool's Domino® loose tenons. A few pocket screws were also used. Each of the tops has xenon lamps flush mounted within. Lacewood (also known as Australian silky oak) was used as an accent strip in the valences.

Construction involved use of several Festool® products including TS 55 and multiple MFTs (old style), Domino® machine, OF 1400 router, RO 125 sander, ETS 125 sander, LS 130 sander, CT 22E vacuum, LR 32 Hole Drilling set, Festool Edge Stops and shop-made Side Stops with extended range, router table, Kreg® pocket jig with shop-made dust collection hose adapter, and Fuji HVLP spray finish equipment.

I will also try to describe in detail the finish system I used, including the problems encountered. A combination of solvent and water-based materials were used. The final finish coats are water-based lacquer from Target Coatings (Oxford brand).

While working on completion of this Entertainment Center, I plan to build a complementary square-shaped coffee table with a granite top. I obtained the 3 ft x 3 ft granite piece yesterday. I'm still thinking about various design ideas and alternatives, and how to deal with the weight of that top and the table which will be located near the middle of a room supported by 20 ft long clear span joists. That floor is structurally adequate, but a little “too bouncy” and I am concerned about excessive deflection, essentially turning the floor into a large, shallow bowl. Reinforcing that floor structure will be another major project since all the HVAC and wiring were installed about 20 years ago.

Here are a few photographs of the completed and assembled Entertainment Center unit.

Closeup view of top lighting and valence of red oak and lacewood (aka Australian silky oak).

Effect with glass insert shelves.

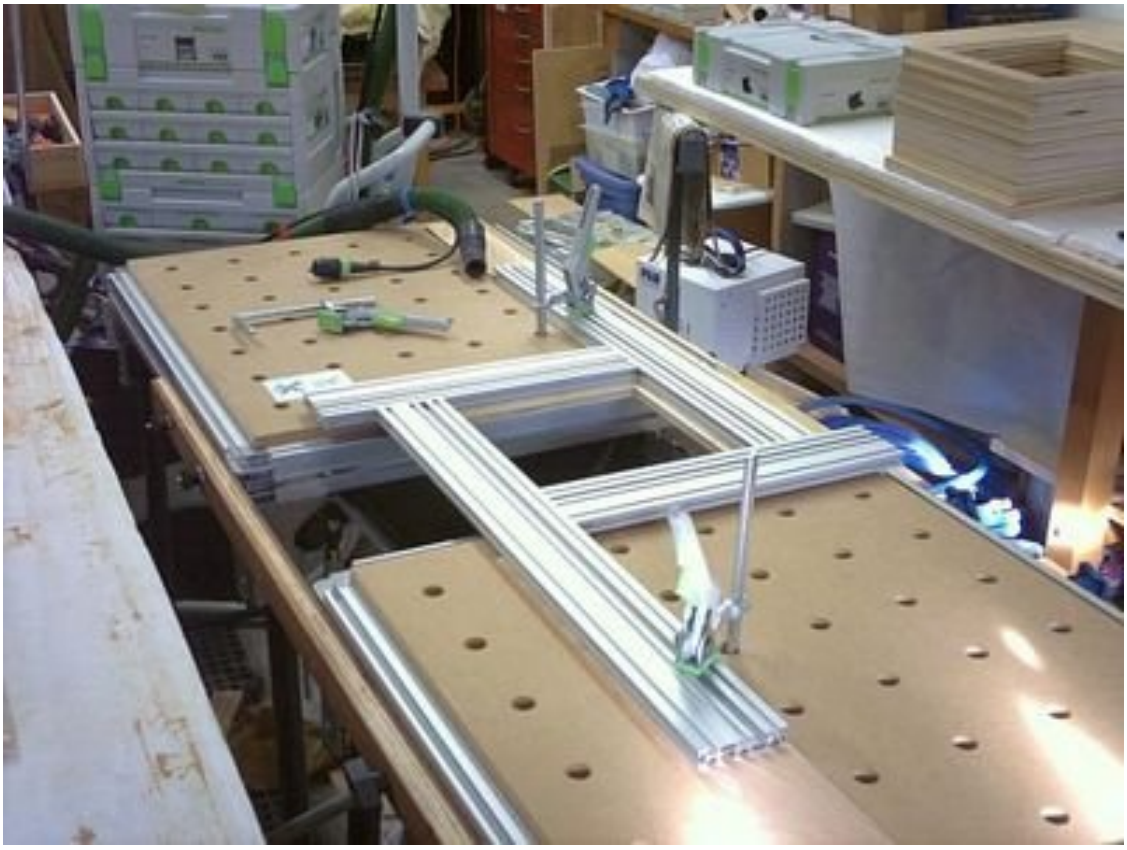
Effect with solid panel shelves.

Close-up of valence surrounding tops of Bookcases and TV Cabinet.

And what my wife to rearrange those symmetrically arranged, adjustable shelves. I guess I'll have to go build more bookcases!

Here is another photograph under different lighting.

Double MFT setup with MFS and bottom mounted dust collection for routing shelves for glass inserts.



Bottom mounted Dust Collection

Chapter I

Construction of Console for Entertainment Center – Ripping of Sheet Stock

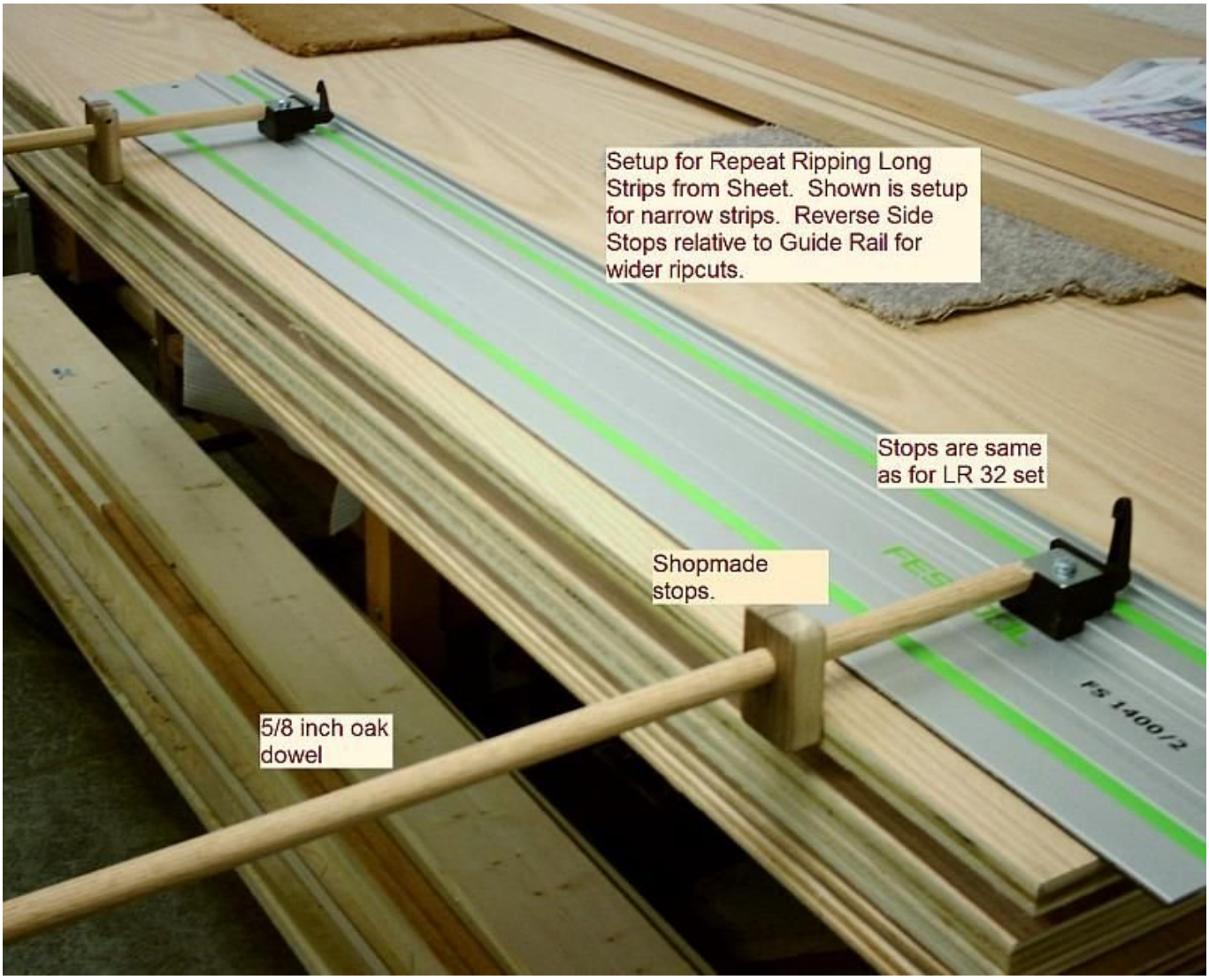
Inspiration for the design of this entertainment center including some of the Console features was taken from a photograph of a system shown to my wife by a professional decorator. That unit was only available in jatoba, only in one finish which was too dark to match the stained oak wall and trim in the living room in which the unit was to be located. The dimensions of that commercially available entertainment center/wall unit weren't quite right, either, for the room in which the unit was to be installed. They were too short. Initially, my wife wanted a "cubist" appearance when viewed straight on from the front; she wanted the shelves and partitions to form a stacked array of nearly square boxes of nearly equal size as shown in picture of the commercial unit which had fixed shelves of solid panels. I changed that to adjustable shelves with glass insert panels (so that lighting from above could pass downward through the upper shelves to lower shelves), and made a couple of extra shelves with solid panels just in case she wanted to shift the appearance. To complement some other furniture we have, the doors were fitted with “pebbled” glass panels. I made them so the panels can be easily replaced, if needed or desired. You could substitute a different type or color of glass or even leaded glass, or panels of contrasting or figured wood or metal such as one of the many decorative copper panels that are available. Architectural supply catalogs and websites are good sources of ideas and materials for your consideration. I only regret that I did not happen upon any of these sources until my project was almost completed, too late to make many changes.

For stability, the sides, top, partitions and shelves of the Console are made of plain sliced, red oak veneered plywood edged with solid oak. (This was my first project ever in which I used veneered plywood for any exposed panels.) To add a little visual interest effect, on the outside surfaces, the front and back edging of the sides stands 1/4 inch proud of the plywood panels. The front edging of the side panels also stands 1/4 inch proud of the inside surface of the plywood panels, but the back edging is flush with the plywood

The Console is designed to be used with a flat screen TV and common DVD player, and Warner Cable (Scientific Atlanta) DVR, with storage in four drawers behind the doors for DVDs and CDs. The Console is 52 inches wide, 19 inches deep and 24 inches high.

To make the panels, 3/4 inch veneered plywood had to be rip cut (parallel to the 8 ft length of the plywood sheet) and then cross cut. The widths of the ripped pieces ranged from 12 inches to 17 inches (and for the backs of the Bookcases more than 27 inches). For many of the needed components, multiple ripped panels were needed.

To help ensure uniformity of width of the ripped panels, I made a pair of extended range Side Stops as shown in the photograph below (***please note that the tag should read "3/4 inch oak dowel***" not 5/8").



As you can see, these are really nothing more than an adaptation of what Festool already offers. The heads of these stops are the same as those supplied with Festool's Edge Stops (Item #485758) that are marketed for use with Festool's LR 32 Hole Drilling set (Item #583290). If you have the Hole Drilling Set you can substitute longer rods to extend their range. Hexagonal aluminum rods having a 5/8 inch dimension across the flats would be nearly perfect. But since I did not have access to any of these, I substituted a pair of 3/4 inch diameter dowel rods, and ground a flat on one end of each rod to enable it to be gripped by the top plate of the head of the stops. (After posting my wood dowel based idea, Todd, another member of FOG posted a message that hexagonal aluminum rods can be obtained from Online Metals.)

Although I have the Hole Drilling set, I chose to purchase additional pieces to enable use of a pair of Festool Limit Stops (Item Number 485827) I own for my Side Stops purpose. Thus, I don't have to recalibrate my Side Stops for use with the Euro 32mm system. Because the bodies of the Festool Limit Stops are identical to those of the Festool Edge Stops, all that is needed to complete conversion of a Limit Stops for use in my Side Stops is a top plate, a 6mm machine screw and square nut. Bob Marino worked with me to obtain the correct Festool OEM hardware plates, but suitable plates can be made easily from aluminum plate and

Imperial screw parts.

For the adjustable End Stops (at the far end of the dowels opposite the black plastic heads that mount on the “hat” of the Guide Rails), I simply bored a 3/4 inch hole through a couple of blocks of hardwood (black walnut in the photographs), then bored and tapped them to receive a 6mm machine screw (so I can easily tighten them with my "Toolie Tool" or any Phillips screwdriver). **It is important that the 3/4 inch bore through these End Stop blocks be perpendicular to the face that will be in contact with the work piece to be cut, so use a drill press if available.** If the bore through the End Stop Block is not perpendicular to the face to be used as a reference, the registration of the Guide Rail will vary with thickness of the workpiece on which the Guide Rail with your shop-made Side Stops is positioned. If you have not tried it, you may be surprised how well hardwood accepts being tapped with ordinary metal working taps. Metric taps are available at many hardware stores. Mine are Ace brand and were only a few dollars each. The main difference compared to tapping metal is to more greatly undersize the bore to be tapped. A little boiled linseed, tung or other curable oil finish on these wooden threads will serve to strengthen them, but it is not necessary. After boring and tapping the End Stops, I used a band saw to cut through the short end of each block, then made at least a pair of additional kerfs in the blocks beyond the main bore. These kerf cuts allow the block to be snugged in position against the dowel rods without splitting the blocks. These blocks could also be made from HMPE (dense plastic) block or sheet.

To set these shop-made Side Stops for ripping wide (or narrow) strips off a sheet of plywood, I simply mark the ends of plywood at the desired width, then set the rubber edge strip of the Guide Rail on the mark. This enables you to position the Guide Rail close to parallel with the reference edge of the sheet to be cut. Then I mount the Side Stops adjacent to each other at one end of the Guide Rail and adjust both of them until the End Stops (wooden blocks) are in contact with the reference edge of the plywood sheet. Doing so assures that both Side Stops are set to the same width rather than relying on both pencil marks. [Side Note: If you needed to make several tapered ripcuts, you could set the Side Stops at each end of the Guide Rail to different lengths, but that is not needed or desired for this Entertainment Center project.] After setting the Side Stops using only one of the pencil marks as my reference, I move one of them to near the opposite end of the Guide Rail. Then I reset the Guide Rail on the sheet to be cut, then make the cut. To setup for the next cut, the Side Stops are again mounted near to the opposite ends of the Guide Rail, the Rail is positioned on the sheet using the previous cut line as a reference. The Side Stops are then removed, and the next cut made with the TS 55 saw. I was surprised how close to exactly the same width the ripcut panels were.

Here is a photograph of a stack of ripped plywood panels for this Entertainment Center project, not just those for the Console which did not require as long pieces. It turned out that I actually needed more than these to complete this project. That was not a problem, I simply used one of my previously cut pieces to reset my shop made Side Stops to the needed width and cut additional strips for the shelves of the Bookcases and TV Cabinet.

Although I am focusing on construction of the Console in this section, in practice I ripped nearly all of the plywood sheet panels that I would need at this time. Due to my small crowded shop, I used an old workbench to store my inventory of 10 sheets of plywood. I ripped many of those sheets right on that stack. Due to my working alone, most of the time I did not move the sheet to be cut other than to lift it up to slip panels of foam insulation board underneath prior to cutting. [I did shuffle some of the sheets at the beginning of the project so I could select the best face veneer for the panels that would be exposed in the completed Entertainment Center.] After supporting the sheet to be cut on panels of foam insulation board, the Guide Rail was positioned on top for the cut. At first I clamped the ends of the Guide Rail, but eventually came to trust it to stay in position which it did.

The front edges of the side panels are edged with 1 inch thick by 1 1/4 inch wide solid oak located and fastened with Domino tenons and glue. The back edges of the side panels are edged with 1 inch thick by 1 inch wide solid oak strips similarly attached with Domino tenons and glue. On the insides of the side panels, the back edge strips are flush with the inner surface of the plywood, whereas in the front, the edging overhangs the panels by 1/4 inch both to the outside and to the inside.

My setup for this is shown in the following three photographs. It is a pair of Guide Rails joined by Festool connectors (Item #482107), clamped onto a long board of 5/4 oak of the same

stock to be ripped into narrow strips. In the photograph is a 3000 mm Guide Rail joined to a 1400 mm Guide Rail spanning multiple tables. Most of my 5/4 (true 1 inch thickness) oak boards were 10 to 12 ft long. I ripped a straight edge on one of them using the TS 55 and Guide Rail, then ripped a strip 1 inch wide and another 1 1/4 inch wide. I used pieces cut from the 1 inch strip as a gauge block to set the "fence board" clamped underneath the Rail back the desired 1 inch distance.

Below is another photograph showing my TS 55 positioned near the end of the Guide Rail, ready to rip a narrow strip from off the shorter board whose edge is abutted against the longer board that is clamped under the Guide Rail.

One caution is in order when using this technique. As the stock board being ripped into strips becomes narrower, it may warp due to internal tension that is released as the strips are cut. Some of the ripped narrow strips may warp a bit, too, but those can be “coaxed” into straight line when they are joined to the edges of the panels. Any narrow strip that more than a wee bit warped was used for the shorter pieces of edging. When I encountered this problem, I used my jointer to recreate a straight edge to abut underneath the Guide Rail. If you don't have a jointer, you can set the crooked edge just barely under the Guide Rails and rip a fresh straight edge. In this case, be sure to keep the board to be cut from moving during the ripcut since it will not be captured under the Guide Rail.

Chapter II

Cross-Cutting of Previously Ripped Stock

After ripping the plywood sheets for the panels and ripping the 5/4 oak boards into narrow strips, I needed to crosscut these into the various lengths needed. For this I used my MFT 1080 and TS 55 connected to my CT 22E through an Oneida Dust Deputy.

Placement of an MFT 800 to the left of my MFT 1080 equipped with the Festool-supplied fence and crosscut Guide Rail supports provided ample support for the longer pieces to be crosscut. These two MFTs were connected using Festool's metal connectors (Item #484455). Although the longest pieces for the Console were only 52 inches long, those for the Bookcases were nearly 7 ft long. For support to the right side of the saw of the stock to be crosscut, I set up an auxiliary table by simply laying an old flush hollow core door on a pair of sawhorses. I got lucky because the elevation of that auxiliary table nearly matched that of the MFT top. No shimming was necessary. Some of the strips to be crosscut were ~12 ft long and while many of the pieces to be crosscut from them were only a little more than 1 ft.

The photograph immediately below shows some of the crowded conditions in my small shop. I was against the overhead door when taking this photograph.

Needless to say, this lengthy arrangement of MFTs and auxiliary table took up a lot of floor space in my 15 ft X 25 ft garage/shop which also houses a table saw, bandsaw, Shopsmith, cyclone dust collector, tool chests, welding equipment, spray equipment, car repair equipment and much of my wood stock, including all used in construction of this entertainment center, and more for later use in making substitutes for Systainer-Ports. Although I have a basic Hitachi CMS, sometimes the shop was so crowded with stock and work in progress that I had to resort to an ancestor of the Kapex compound mitre saw.

As you can see in the two photographs above that showing the handsaw and the two immediately below, to protect the top of my MFT 1080, I use a 2 ft x 4 ft piece of quarter inch plywood, which I clamp to the top. To aid in aligning the stock to be crosscut, I clamp a piece of scrap wood to the right of the MFT fence and in-line with it. This also seems to slightly improve capture of the sawdust as the saw blade passes through the far end of the stock being crosscut. I recommend using a board somewhat wider than is shown in the photographs so the blade kerf ends within the auxiliary fence rather than spinning in free air beyond the fence. Note also that I moved the MFT aluminum fence about an inch to the left after cutting a nice 45 degree mitre through it during an earlier project. (The picture frames came out quite well, and the 48T blade was not harmed, I used the same blade without resharpening for this project.) Such mitre cuts will be needed later when making the valences on the Bookcases.

Here's another view from the backside of the MFT:

Squaring the MFT for Crosscutting

There has been much discussion on this forum about squaring up the fence to Guide Rail on the old style MFT 1080 and MFT 800, and the nuisance of having to re-square it every time it is removed from the MFT and replaced. My experience confirms that squareness should be rechecked made every time the Guide Rail Supports are removed and re-installed, if true 90 degree crosscut accuracy is needed. But there is an easy, quick solution to this issue. Get or make a large (12 inch or greater) precision square and keep it handy by the MFT. I chose an 18 inch aluminum 45-45-90 degrees triangle carpenter's square from Woodpeckers; although pricey at about US$ 110, I have found it useful for many tasks involved in making this Entertainment Center, and strongly recommend getting a this or an equivalent product. I found this large square invaluable for use in my unorthodox technique for use of the LR 32 and Hole Drilling set which will be discussed later.

Woodpecker Carpenter Triangle
These are available in 12” and 18” sizes. I chose the larger one.

To square up the MFT fence to crosscut Guide Rail, I lower the hinged end of the Guide Rail support so that it rests on the aluminum fence, place a scrap of one-half inch plywood under the Guide Rail to support it along its length, lower the Guide Rail and adjust the height of the Guide Rail Support tab holder nearest the operator so the tab is fully engaged in the slot underneath the Rail to prevent side movement of the Guide Rail. I do not setup the Stop bolts

mounted in the side channels of the side rails of the MFT to apply any sideways tension within the Guide Rail when the end near the operator is engaged in the tab; however, some MFT users recommend that procedure to remove any play when the Guide Rail is down in the tab. Then I lay the Woodpeckers precision square on the MFT with the thicker side of the square against the Guide Rail and the thinner side against the MFT fence. I make whatever adjustments are needed until full contact of both sides of the reference square with the MFT fence and Guide Rail are achieved. I confirm this by slowly sliding the reference square into the inside corner defined by the MFT fence and Guide Rail after the MFT components are "locked" in position. Occasionally I find I have to readjust the stops in the Side Rails of the MFT, and the Festool-supplied clamp that secures at the far end of the fence to the top of the side rail of the MFT. I frequently find myself completely removing all of the fence hardware from my MFT including these stops in the side rails, and I don't find it takes much time to reinstall and reset the fence to be square to the Guide Rail. You can make pencil marks on or within the channels of the side rails to facilitate recreating a previous setup position of the Fence and Guide Rail if you desire, but it is not necessary. When delivered, the stops on my MFT 1080 were not correctly preset for the Guide Rail so I got used to setting them right at the start of my Festool experience.

For the components to be crosscut whose cut length was within the range of the MFT fence, I used the Festool Adjustable Stop (Item #49055) supplied with the complete MFT 1080. For components whose length exceeded that of the MFT fence, I used one of the two setups shown in the following photographs. One setup was a scrap wood block clamped to the top of the extra MFT 800 positioned to the left of the saw as shown in the photograph below. This is not my preferred setup. If this setup is used, be sure to clamp the block down with a pair of clamps; using only one clamp may result in the stop block moving when the stock to be crosscut is slid into position. The mass of a large panel of plywood bumping even rather gently against a Stop Block held with a single clamp may be enough to make it move, and thus a potential source of cumulative errors. I learned this the hard way after cross-cutting some of the plywood panels. Then I added the second clamp and had to re-cut the panels to a slightly shorter standard length, so my drawings and my actual construction are not exactly identical.

Here's another view of the Wooden Block as a Stop with a pair of Festool Quick Clamps (Item #491594) holding the block to the MFT top.

The other setup, which I prefer for crosscutting long wide stock, utilizes a Squaring Arm (a concept from Jerry Work's MFT manual) extending across the extra MFT 800 and secured to its side rails, as shown in the photograph below. After trying this idea, I preferred it because of the rock solid support that it provides all along the base of the (wide) stock to be crosscut. The reference square placed with one leg against the MFT fence and the other against the Squaring Arm can be used to make this a precision right angle setup as well as a cross-cut stop. Because the lengthwise edges of my Squaring Arms are rounded over (one fourth inch radius), a little sawdust trapped under the reference edge of the stop against which the stock to be crosscut was abutted did not interfere with getting accurate, repeatable contact with the Stop as might occur with use of a scrap of wood for a stop as in the first setup. Use of the

Squaring Arm as a repeat crosscut stop also freed up a pair of F-style clamps, and was very stable. Sliding a large ripped panel firmly against this stop did not change the setting of the Squaring Arm as a stop. Note that the Squaring Arm stop can also be clamped midspan to the top of the MFT to further secure its position setting.

Here's closer view of the Squaring Arm used stop for repeat crosscuts to exact length:

The little strip of 1/4 inch thick oak positioned under the panel on the MFT 800 is to compensate for the use of a sheet of 1/4 inch plywood on the MFT 1080. I made several pieces of this 1/4 oak stock initially expecting to use them as trim around the bases of the cases of the entertainment center, but the customer (my wife) did not want that aesthetic feature. Nevertheless, they came in very handy as shim stock for many of the tasks needed to construct this furniture because their thickness corresponded to the amount of offset between

the side panels of the four cases I built and the front and rear edging as viewed from the outward sides.

Cross-cutting Long Pieces of Ripped Stock on the MFT in a Small Shop

To set the Stop to the cross cut length desired, I used an ordinary retractable steel tape measure (Stanley brand) and placed a pencil mark at the desired length. As a precaution, especially when cutting plywood panels, to length, I first checked the end that was about to be positioned against the stop for squareness and a good (smooth) cut end. The factory cut end of some of the plywood I was using was good enough that I could use the factory cut end. And the gross dimensions of the full sheets were about 48 1/2 inches by 96 1/2 inches, which enabled ripping four full length panels each 12 inches wide from each sheet. (This was not true of the lower cost birch veneer plywood I purchased a year ago from HD, which came from China.) If the factory cut end was not square or was too rough or the end of a board was checked, I marked across the "bad" end then measured out a length slightly beyond the needed final length.

For shorter components, all I had to do was flip the Festool Adjustable Stop up out of the way, cut the stock a little longer than final length, flip the stock to be cut end for end keeping the same edge against the fence and against the lowered stop, and make the second cut to final length.

For components longer than the length of the MFT fence, after marking the stock to a length slightly longer than the desired final length, I lifted the factory or other "bad" end over the shop-made Stop and crosscut the piece slightly longer than needed, then flipped the stock end for end keeping the same reference edge against the fence, and pushed the previously cut end against my Stop, and made the final cut. This was possible with longer components because they could easily be flexed enough to hold them square against the MFT fence and down against the top of the MFT. This avoided the need to first make a square crosscut on every piece of long stock, then flipping each piece of long stock (some more than 12 ft long) end for end in my small shop, then setting the Stop and making the final cut. My method meant the maximum stock length I had to flip end for end was a little less than 7 ft long (the side panels for the Bookcases). I did this because much of my garage/shop has only an 8 ft high ceiling, and this low ceiling together with the Boom Arm on my CT 22 makes it a challenge to flip long boards end for end without opening the garage door and taking the boards outside to flip them. (I was also very thankful at this time that I paid extra to have the center section of the garage roof built with a "cathedral" ceiling to gain a little more height.)

Chapter III

Playing with “Dominos,” making a lot of holes in my boards.

After cutting the components to width and length, I marked them using a graphite pencil where I would later want to remove the marks, and sometimes used a permanent marker on ends and edges that would not be seen upon assembly or installation, and began to machine the many mortises using my Domino machine. (A gray Eberhard Faber Artgum eraser works great for removing graphite pencil marks, much better than pink rubber erasers.) I didn't keep count of the number of Domino tenons used in the Console but I did for the TV Cabinet that sits on

top of the Console in which there are one hundred 5 mm size tenons. For some of the mortises, I used the base of the Domino machine as my reference while at other times I used the fence. Likewise, for some operations I used the bottom surface of the workpiece as a reference while at other times I used the top surface. Frequently, I used the 1/4 inch thick oak boards I had prepared as shims to support the workpiece or the Domino machine.

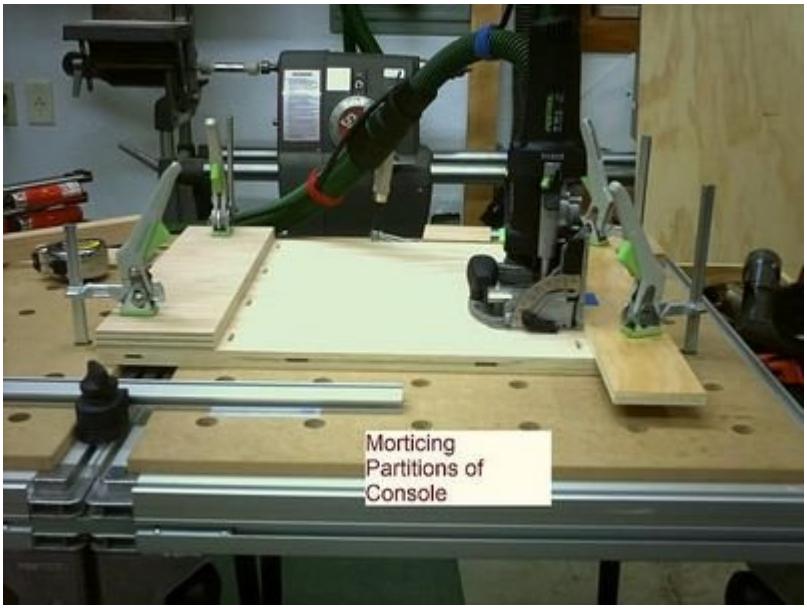
The order of construction of the Console is as follows. The photograph immediately below of the mostly complete Console may help a reader to follow my description.

The side panels are permanently joined to the base panel and to the short shelves on the left and right with glued 5 mm Domino tenons. In like manner, the vertical partitions that support the adjustable / removable shelves in the center are joined to the short permanent shelves with Domino tenons. The vertical partitions are joined to the base panel with screws, although I did make a few Domino tenon holes before I changed my approach which you can see in the foreground of the following photograph.

First, I first marked the plywood panels that would become the sides, and cut the two rows of mortises into the inside faces of each side panel. To ensure placement of the mortises at the desired elevation and front-to-back edge registry, I made a template using a scrap of plywood. On both side faces of that template I marked lines identifying the reference edge of the template to be lined up with the reference edge of the side panels, e.g. the "front edge", and lines corresponding to the centerline (widthwise) of the Domino mortises to be cut. Using my large precision carpenter's square, I drew lines across the side panels that I used to position the template I had made. With the template clamped in place over the panel on the MFT, accurately locating and cutting the mortises so all the pieces would join together as intended was relatively simple. Here is a photograph of the template in use to cut the mortises in the side panels. In this photograph, the mortises are being cut for the base panel. Note the orientation of the Domino machine, its base is being used as a reference against the template. Actually this is not the true original template that I used, that template is on the right in this photograph and the next two photographs.

Because the base panel is made of 3/4 inch thick plywood, the mortises to be made in the ends of the plywood base panel using this technique (referencing the mortices off the base plate of the Domino machine) will not be located at the centerline of the thickness of the plywood, they will be slightly above the centerline of the plywood. To correctly match the mortises to be made in the base panel, the Domino base and bottom side of the base panel have to be used as the reference surfaces. If these reference surfaces are not kept straight as the work proceeds, the base panel is going to be at a different elevation than intended (in this case higher) and the mortises to join the shelves and partitions are not going to match as intended. This is because I did not take care to ensure that the spacing within a row of the mortises was equidistant from the front edge and back edge and one another. There is no need to make them so. Worse yet would be to use different reference surfaces for the left side and the right side components of the Console, unless perhaps you're trying to make a modern art statement.

Below is a photograph showing the orientation of the Domino machine to cut the upper row of mortises in a side panel. The piece of 1/2 inch plywood is the actual “original” template I made and used. These mortises will be used to join one of the two short permanent shelves to a side panel. (I apologize for the text box within the photograph incorrectly stating this is a partition panel.) Note that the reference surfaces are now reversed, and that fact must be kept in mind when cutting the mortises in the corresponding short shelves.

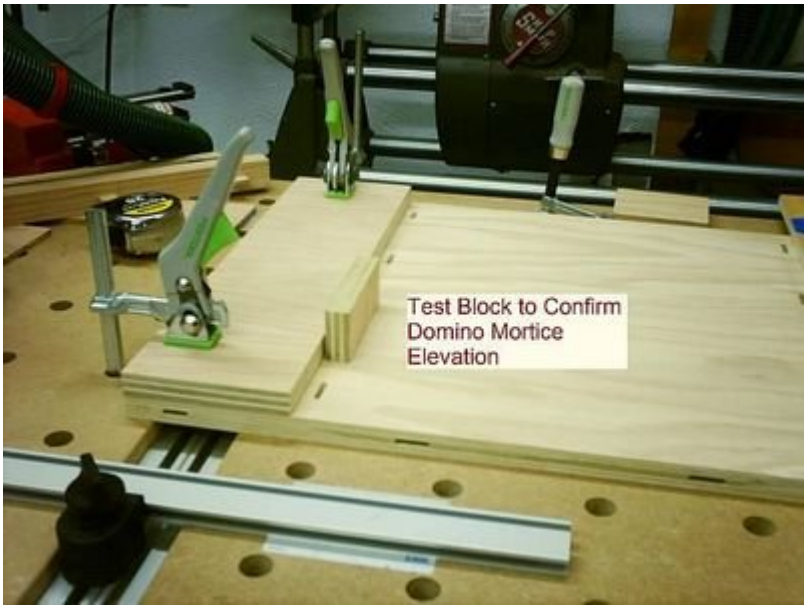


Lastly, in the photograph below I have inserted my "Check Block" which is nothing more than a short piece of plywood into the edge of which I have cut a Domino mortise. The check block is marked to indicate which would be the best face veneer of the plywood. Note this check block can also be used to help ensure correct placement of the template and relative orientation of the Domino machine and panels prior to cutting any of the mortises. You can also barely “kiss cut” a mortise to a shallow depth, remove the Domino machine and use the Check Block to confirm the mortise is where you want it before machining the mortise to its full depth. The accuracy of the various reference markings on the Domino machine makes it easy to visually realign the machine on a pencil mark or line.

In the first photograph below there is shown the Check Block correctly inserted into a Domino mortice, confirming correct elevations of the mortices and thus the top and bottom faces of the

cross panels to later be jointed. [I chose the wrong photographhgraph in my original post to FOG.]

If the Check Block was reversed face for face, there would be a gap between the face of the Check Block and the top edge of the scrap of plywood that is clamped across the side panel. As viewed in the photograph, the right edge of the scrap is lined up with what will be the location of the bottom surface of the bottom panel when the Console is assembled. Note the small gap between the top of the plywood scrap clamped across the panel and the Check Block.



The mortises in the edges of the base panel and the short shelves were cut with the shelves clamped flat against the top of my MFT, with the base of the Domino machine referenced against the MFT top. When mortising the ends of the base panel, the **bottom** surface of the panel was placed in contact with the MFT top. When mortising ends of the short shelves, the **top** surface of each shelf panel was placed in contact with the MFT top. Because no other components are located immediately above or below these short shelves, the shelf pieces could have been flipped end for end upon installation and still fit perfectly horizontal, but the elevation would be slightly different (higher in this example) than intended and the chosen (better appearance) veneer face of the panel will not end up where it is desired. For that reason, I also marked each panel so I could identify each face and edge, and whether it was to become part of the left or right side of the Console. I put the better veneer face up on these short shelves, in turn that required the better face be placed down against the MFT top when cutting mortises.

I used the same template used to locate the mortises in the side edges of the bottom panel and short fixed shelf panels. At first I used the template like a story stick to mark the centerline location of each mortise in the ends of the bottom panel and short shelves. I lined up the reference line at the side edge of the template with the front edge of the panel and then used the lines on it to mark on the panel whose edge was to be mortised. Then I removed the template and drew a series of lines on the face of the panel using a small square, and used those lines to line up my Domino machine for each mortise.

Soon I realized that that additional marking using the template was not necessary. All I had to do was place the panel with the correct face down against the MFT top, then position the template on top of the panel and lined up with the side edge of the panel and the front edge of the panel chosen as a reference, clamp down the template to the MFT and cut the mortises.

Use of Domino machine to cut mortises for application of solid wood edging strips to 3/4 inch plywood panels.

The front and back edges of the side panels have solid oak strips attached with glued 5mm Domino tenons. The front edge strip is 1 inch thick and 1 1/4 inches wide, and joined to the panel so that the edging overhangs both faces of the side panels by 1/4 inch. I marked the top and bottom ends of the strips and the panels and their faces and also numbered them so I would know later which pieces should be joined and in what orientation. I did not use the registering dowel pins or the Cross Stop (Item #493488). I have had some problems in the past when using these with (Chinese) plywood due to some debris hanging within a previously cut mortise interfering with registry of the dowel pin. At about US$85 per 4 ft x 8 ft x 3/4 inch sheet, I did not want to ruin any of that plain-sliced oak veneered plywood, or risk learning that the veneer on later purchased plywood did not match my stock. In my prior use of the dowel pins to register successive mortises along the workpiece, I found that I had to peer under the Domino machine after cutting a mortise to ensure that the dowel pin was fully engaged against the end of the mortise I had just made and not catching on some "chaff"; that seemed more work and a risk of problems that I could easily avoid. So, instead of using the locating pins, I used pencil marks and visually aligned the Domino machine for each mortise and had zero problems when joining the associated components.

To facilitate marking the mortise locations for adding edging to the panels, I placed each panel with its edge confronting with the face of the edge piece to be joined to it on the panel and lined up so their exposed edges were flush. While holding them in this position, I drew a series of lines along their exposed long edges corresponding to the locations of the Domino tenons, placing one about 2 inches from each end of the strip, and about every 6 inches there between. I also marked one end of each piece to be morticed to be the reference, so I could cut the first mortise nearest this end of the associated pair of workpieces was cut with the Domino machine on its narrowest mortice width setting. For the remainder of the mortises, I either used a wider setting, or plunged using the narrowest setting, then moved the Domino slightly to a side of the centerline and plunged again. By making the first plunge slightly to the left of the centerline I had marked and the second plunge slightly to the right of that centerline, I could quickly make a series of mortises that were just a little wider than the Domino tenons yet narrower than the middle mortice width setting on the Domino machine. I don't like having any more void area within my projects than is necessary to assemble them. Then I used a small square to continue those marks onto the adjacent faces of the pieces to be mortised, so the marks would be visible when using the Domino machine.

There are at least three different techniques to mortise the edging and its associated panel to assure they line up as desired when assembled. One is to reference off the bottom surfaces of the Domino machine and workpiece. A second technique is to reference off the top surfaces of the workpieces and not worry about getting the mortises exactly in the middle of the thickness of the workpieces. A third technique is similar to the second technique, but care is taken to set the height of the Domino fence so that the mortises are very near the midpoint of the thickness of the workpieces.

The first technique is shown in the photograph immediately following this paragraph. Although the following photograph depicts use of the Domino machine to mortise a rear edging strip for either the TV Cabinet or a Bookcase section of the Entertainment Center, the same technique was used to mortise the edging for the sides of the Console. The setup shown in the photograph will cause the front and rear edging strips to stand proud of the panel by the thickness (1/4 inch in construction of this project) of the shim boards placed under the panel and base of the Domino machine. If you look across upside surface of the panel (which will be

the inside surface in the finished construction), you can see that the edging on the opposite (which is the front) edge of the panel stands proud of the panel. The face of the panel that is up in the photograph is the inside face and the back edge of the panel is in the foreground just behind the edging strip. Both the Domino machine base and the panel behind the edging are being supported on strips of 1/4 inch wood, and what will become the outside-facing face of the edging is clamped down in contact with the MFT top as needed. **It is very important to keep correct the surfaces of the workpieces when marking and later when cutting the mortises to ensure the components will go together as intended. The edging strip to be marked is oriented with its face that will be joined to the panel confronting that particular edge of the panel, and the edging strip is flipped end for end about a vertical axis thereby keeping the same side upward for cutting the mortices with a Domino machine.** If, instead, you flip the edging strip about a horizontal axis, your mortices will likely be cut at the wrong elevation, unless the thickness of your edging stock is exactly that required to cause the mortices to be mid-thickness of the stock. But your prior identification of the various surfaces and ends of each piece should help to prevent this mistake.

I used the technique shown in the above photograph for application of some of the edging strips, but I also used a second Domino mortising technique in which the mortise elevation is referenced off the top surface of the workpiece to be mortised. This second technique is much preferred when you want a surface of the edging to be flush with the panel to which the edging will be joined with Domino tenons. In this technique the fence of the Domino machine is set at 90 degrees (such that the flat face of the fence is parallel to the cutter) and is pressed down onto the reference surface of the workpiece to be mortised. If you go to the FOG Gallery and enter "domino" in the search box, you will find among the "hits" a photograph (IMG_7390.JPG) by Bill Wyko that shows a mortise being made using this technique into the edge of a sheet / panel he created. Referring to my photograph above, if the Domino machine is reset to have its fence at 90 degrees (so face of the fence which is its registration surface defines a plane parallel to the axis of the cutter) as shown in Bill's photograph and is pressed down by the forward handle on the fence onto the surface defined by the top surfaces of both the edging strip to be mortised and the panel surface behind the strip, the inside surfaces of the edging strip and the panel will line up flush when the parts are joined. Note how the top surface of the

edge strip being mortised is flush with the surface of the panel. This second technique is the one I most recommend for applying edging where the joined surfaces must be very near to flush and you don't want to have to use a flush trim router bit after joining them, and you don't dare risk sanding through the thin face veneer of the plywood. For me, this technique produced elevation-matched pieces that needed only some scraping and light sanding which did mostly with my ETS 125 and LS 130 using 120 grit and higher abrasives. I made certain that none of the shim boards shown in my photographgraph used in the first technique were positioned under the base of the Domino machine so it could not rest on them instead of registering only through the Domino machine fence. When using this second or the third technique, either elevate the workpiece relative to the top of the MFT to provide clearance under the bottom of the Domino machine or position the workpiece so it is cantilevered out beyond the edge of the MFT so the base of the Domino machine does not contact anything and all registration is made by the Domino fence.

I also used a third technique in some of the construction of this project. If I wanted the mortises to be very near to the center of the thickness of both the plywood panels and the front edging strips, I found that, too, was not hard to do. I also used this technique to cut mortises into the side edges and ends of the edging strips to form a face frame upon assembly of some of the front frame pieces of the Entertainment Center. I did not get to this confidence level until construction of the TV Cabinet which I made last. I measured the actual thickness my plywood using a digital caliper (available from Woodcraft and others for about US$40), then set the height of the fence of the Domino machine to one half the measured amount. Perfect centering was not needed for this operation. As I progressed through construction of this Entertainment Center and experimenting with use of the Domino machine, I realized that I could come very close to the center of the thickness of the plywood or wood edging strips by simply marking the centerline of the wood piece then eyeballing the location of the Domino pins as I adjusted the height of the Domino fence. I also noticed on my Domino machine, when viewed at front quarter angle from either side, there is a highly visible horizontal mold partition line in the aluminum housing adjacent the bosses into which the dowel pins are fitted that appears to closely correspond to the centerline in elevation of the dowel pins. I don't know if every Domino machine has these visible features, but I would expect them to. Sometimes I used that flashing/parting line to make the fence height setting when I wanted to center the mortises relative to the thickness of the workpiece. The dowel pins appear to be at the same elevation as the centerline of the Domino Cutter (as they have to be for indexing successive mortices as described in Festool's user manual), so if the dowel pins and that mold parting line appear to be on the thickness centerline of the workpiece to be mortised, so will be the mortise. I also found I could easily visually check the elevation setting of the Domino fence, especially in plywood because the veneer layers serve as a guide. I drew a pencil line corresponding the thickness centerline of the 1 inch edging strips and used this to confirm the height setting of the Domino fence. I needed to do this several times while assembling the TV Cabinet with its fully Domino tenoned front face frame. Checking this visual technique against actual mortises and the thickness of the plywood and other components I was making indicated I could usually get within 1/2 mm of center of thickness with little trial and error. That is close enough most of the time, but probably not if working with thin veneered plywood onto which you are trying to apply a flush edging strip.

As stated earlier, when mortising these edging strips, it is important to first position each strip relative to the panel to which it is to be joined **in the orientation you want the pieces to be when assembled**, and to make your pencil marks for the mortises while in this orientation.

After marking the edging, flip it end for end keeping the same edge surface up, position it against its associated panel and cut the mortises. Again, it is very helpful to mark each piece of edging and panel so you know which pieces go together when you're ready to glue-up. I did not glue on the edging until I completed several stages of dry fit checks and drilled the shelf pin holes using my LR 32 Guide Rail and Hole Drilling Set (Item #583290) with my OF 1400.

For mortising the ends of the edging strips, which I did as I progressed through several dry fit checks, I used Festool's Trim Stop (Item #493487). In contrast to my experience with the Cross Stop (Item #493488), I had no problems using the Trim Stop. I found it very easy to install on the Domino machine and very easy to setup to center the mortise in my 1 inch thick by 1 1/4 inch wide front edging stock, and surprisingly accurate. [Based on this experience, making some chairs may be in my future!] The Cross Stop was not used in construction of the Console, but was used in construction of the Bookcases and TV Cabinet which rests on top of the Console.

Mortising the Edging for the Top of Console

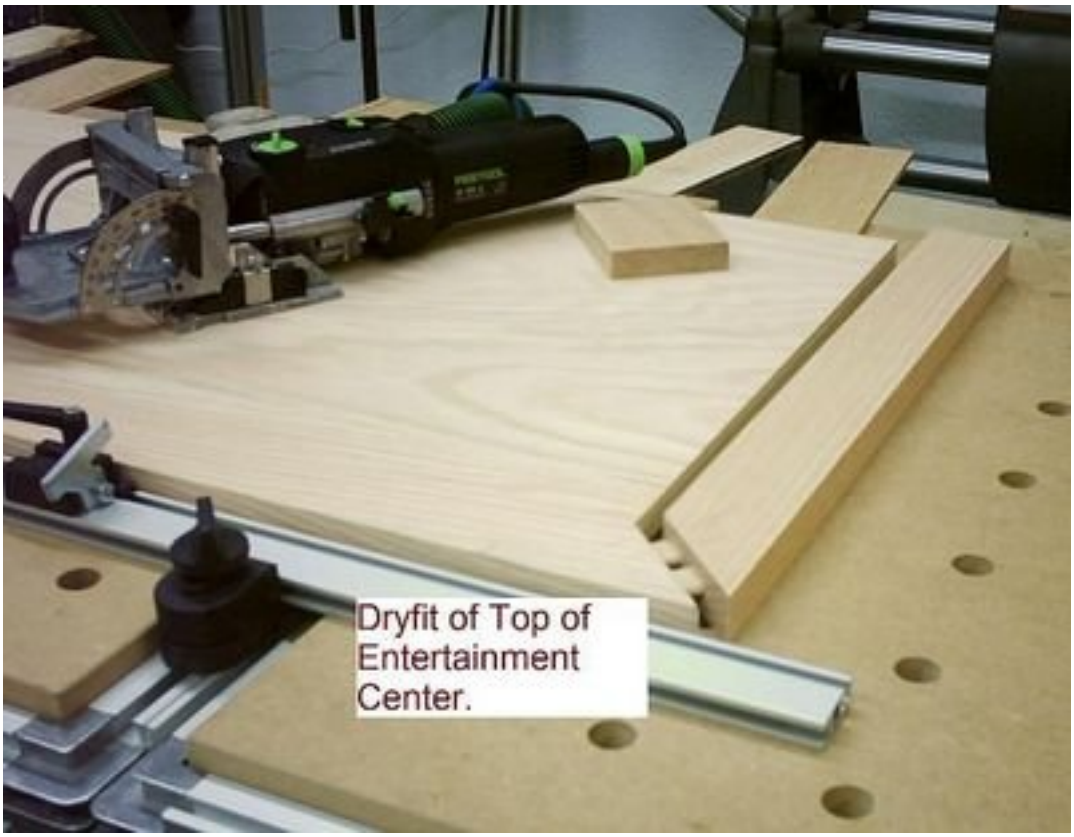
The main panel of the top of the Console is a piece of 3/4 inch veneered plywood. It is surrounded by a mitred three-piece frame of oak stock 1 inch thick by ~2 inches wide. The mitred frame is attached to the plywood panel with Domino tenons. As you can see in the photographs of the finished console, the mitred frame and center panel are flush on the exposed top surface, but offset 1/4 inch when viewed from the underside.

Here's a view of the underside of a front corner of the Console top.

This was my first attempt at using the Domino machine for applying mitred edging, and also my first attempt at cutting the mitre joints in the front piece to exact length. Unlike a picture frame whose center is hollow, there is no room for error here. All of the cut edges must be straight and clean and the elevations, lengths and angles must be exact. My approach to these issues was to always reference the Domino machine off the top surfaces I wanted to be flush when joined, then to machine the mortises into the edges of the plywood panel and framing pieces to be joined. I first cut the framing stock a couple of inches longer than needed, so I could tweak the mitres if needed. Then I cut a mitre on one of the short side frame pieces and on one end of the front frame piece. I made the mitres on my table saw because I did not want to clear my MFTs to do them with Festool equipment. (A Kapex or other quality mitre saw would have been welcome at this time.) After I was satisfied with the fit of the mitred pieces for one corner to one another and the front and one side edge of the top panel, with them in position relative to the panel I marked out the locations of the mortises using a pencil. I did not cut the other mitred corners until I was satisfied with the fitment of the first corner pieces to themselves and the center panel. I did not have any extra 4/4 stock from which to cut new framing pieces, so I proceeded cautiously, incrementally working toward the final goal.

The first photograph below shows the mortises in one of the side framing members. The mortises adjacent the mitre were intentionally made extra wide to enable the pieces to be rotated somewhat into final position as they are slid together. If the mortises are tight relative to the width of the Domino tenons, the mitred pieces with their Domino tenons cannot be assembled to both themselves and to the center panel. Note also the two tenons in the mitre joint. To position these mortises, I simply laid a pair of 5mm Domino tenons on to of the mitred pieces while they rested on the MFT top, and made a pencil mark corresponding to the approximate centerline of each tenon. That visual technique also assured I would not cut through the mitred frame pieces provided I kept the Domino machine set to plunge 15mm, which I did. [If I had wanted to place a tenon closer to the outside edges of the mitred corner, I could have reduced the length of a tenon and reduced the plunge depth of the Domino machine whose least depth stop is 12mm.] Then I removed Domino tenons I had laid on top of the pieces to be morticed and extended my pencil marks using a try square positioned against the cut edges of the mitres. Then I cut the mortises with my Domino machine. I did several dry fit attempts and extended the width of the mortises as needed to enable the joints to be brought fully together and the Domino tenons to be fully seated in their mortises. I could see where the mortises needed to be widened as rotated the framing pieces into position, and made pencil marks to help guide my placement of the Domino machine to widen the mortises. This was easy to do with the Domino machine, all I had to do was simply move the machine laterally from my centerline by the amount I wanted to widen the mortise.

Several dry fit checks were made; the mortises were widened as needed to enable full closure of the mitre joint and contact along the full lengths of the framing members and the center panel.



Below is a photographgraph of the final dry fit check. The glued up photographgraph looks the same. All of the pieces came fully together. The joints have remained fully closed since the

finished Console was brought from my garage into my house a few months ago, despite the lower humidity in the house.

Drilling the Console Shelf Pin Holes

After cutting all the mortises on the panels, I used my LR 32 Guide Rail (Item #491621) together with my LR 32 Hole Drilling Set (Item #583290) and OF 1400 router fitted with a Whiteside brand 1/4 inch solid carbide double-fluted straight bit to drill a pair of rows of shelf pin holes on the confronting faces of the vertical partition panels of the Console.

Because I did not need to adhere to the dimensional standards for the Euro hinge system, I held the panels together in elevational alignment (top edges and bottom edges in line when possible) and used my large precision carpenter's square to draw a line across the inside faces of the panels where I wanted a row of shelf pin holes to begin. Then with a pair of Festool's Edge Stops (Item #4857580 installed on the LR 32 Hole Drilling Guide Rail, I positioned the LR 32 Hole Drilling Guide Rail on the panel to be drilled **with a hole of the LR 32 Guide Rail centered on my pencil line**. This simple technique allowed me to position (in elevation) the holes wherever I chose rather than being limited to the specific distance of a given hole in the LR 32 Guide Rail that will result from use of the Linear Stops that are supplied with the LR 32 Hole Drilling Set (Item #583290) and installed in the end of the LR 32 Guide Rail in use which limits position of the LR 32 rail to specific distances of 16mm and 32mm from the end of the panel to be drilled. (Please refer to the tutorials of Brice Burrell or Overtime or Mirko for instructions on use of the components of the LR 32 Hole Drilling Set (Item #583290) as Festool designed them to be used.) Below is a series of three photographs that illustrate the techniques I used to drill the holes in the Console panels and later in the bookcases. In making the Bookcases, the rows of shelf pin holes were much longer than in the panels and I had to "walk" my 42 1/2 inch long LR 32 Guide Rail lengthwise to continue a single row of holes.

I “walked” my short LR 32 rail lengthwise using the OF 1400 with the ¼ inch bit installed to confirm I had the rail properly indexed. I joined a normal Guide Rail to the end of the LR 32 to enable clamping the LR 32 at the ends of my ~7 ft long workpiece, and clamped a straightedge

behind the LR 32 to act as a lineal guide as I slid the LR 32 along the workpiece. If you don't advance the LR 32 a distance more than its working length, you can slide the router back and forth to confirm that you have perfectly indexed it for the next series of hole. With this technique, you can create a very long row of equally spaced holes if you have a long enough straight edge to back up the LR 32 and a way to lock it in position as you make each successive series of holes. If the hole size you happen to be drilling matches that of the metal dowel pins at the ends of Festool's Edge Stops, you can mount one or both of those on the LR 32 Guide Rail with the distance from the hat of the Guide Rail set to correspond to the distance of the centerline of the LR 32 Guide Plate (Item #492340) when mounted on the LR 32 Guide Rail and use the Edge Stops as an aid in aligning the LR 32 Guide Rail when “walking” along the row of holes being drilled. I am thinking of making some wooden blocks similar to those I made for my repeat rip cut Side Stops but with capability of securing rods corresponding to the size of the holes I commonly drill with the LR 32 -- one to hold quarter inch and and to hold 5mm size rods. Drill bits or router bits could be used, or a tapered (conical shaped tip) pin.

Note particularly how the pencil line is aligned with a hole in the LR 32 Guide Rail.

Results. Holes where I wanted them.

Assembling the Console

You might think by now that I was ready to begin assembling the Console. You'd be partially correct, but not entirely. I glued the front and rear edging onto the side panels, the front edges of the partitions. For the adjustable shelves, I added 3/4 inch thick edging to one long edge and 1 inch thick edging to the other, thus enabling the adjustable shelves in the center compartment of the Console to be installed in either orientation to give a different appearance as shown in the following two photographs.

The photograph immediately below shows the Console shelves with 3/4 inch thick edging in front (corresponding to the thickness of the plywood panel of the shelf).

The following photograph shows the Console the shelves arranged to present the 1 inch thick edging in front.

But those photographs just above are getting ahead of the chronological order in which I built the Console. Due to several small interior spaces, I decided to try pre-finishing the components of the Console before final glue-up assembly. But before that I did another dry fit check. They are difficult to distinguish them in the photograph below, but I made four gauge blocks from scraps of wood to the length corresponding to the width of the narrow permanent shelves (one on the left and the other on the right in the photograph below) and set them on top of the base panel to ensure that the vertical partitions would be correctly located. If you look carefully in the lower left of the photograph, you will see one of the gauge blocks with a small piece of blue tape on its top surface. With the gauge blocks and shelf and vertical partition in place, I installed 2 inch long Spax screws into the partitions through the bottom panel. I also used these gauge blocks for subsequent dry fit checks and for final assembly. Spax screws are premium priced, but they can be used as self-drilling screws in wood and similar materials, and with a pilot hole, even into concrete. (I used pilot holes to mitigate the risk of splitting the wood which I think is more of concern when the screws are being driven parallel to the faces of plywood, in this instance the partitions.) Their heads are very precisely formed and a Number 2 Posi-Drive® bit fits perfectly unlike the sloppy engagement and resulting cam out that often occurs with Phillips head and even square drive (Robertson) screws of lesser quality. About this time I thought I was going to run out of clamps, so many were required for the dry fit checks as additional components were added to the Console dry fit check. (I turned this into an opportunity out of it by having my wife come to see my progress and showed her why a woodworker can never have too many clamps! She had previously questioned why I would ever need as many clamps as I own. Now she better understands.)

While the Console was assembled for a dry fit check, I fit the front edging that would later be glued and secured with Domino tenons, and also the front toe-kick board (not shown in the photograph above). If you look carefully just under the top you will see a board extending from the left side panel to the right side panel. That board and another like it were let into notches I cut into the vertical partitions and fastened to both side panels and both partitions with screws. Due to the absence of 1 inch thick edging on the back edge of the top panel, I inserted ¼ inch thick wood strips between the back cross piece and the underside of the plywood panel of the top before inserting screws.

Dust Collection Adapter for Kreg® Pocket Hole Jig

The toe-kick board was also drilled for installation with pocket hole screws. To make the pocket holes, I used a Kreg jig fitted with my shop-made dust collection hose adapter. I believe that I made the adapter from a section cut from a Carlton brand PVC electrical conduit 90 degree bend, 1 1/4 inch diameter. Festool's 27 mm tool end hose fitting (Item #487071) is too large to fit into the blue-colored dust collector supplied with the Kreg jig, and Festool's 36mm hose fitting (Item #487721) is too large to grip the outside of the nozzle of that collector. Below is a photograph of my adapter in use. If you decide to make an adapter like this, note that you will have to slightly enlarge the end that fits onto the Kreg dust collector shroud by grinding away a little of the inside surface to the conduit. I used a small sanding drum mounted in my drill to do this. The wall thickness of this conduit is quite thick (Schedule 80). To make it easier to select the best size of conduit to begin with, you could remove the tool end fitting from your Festool 27 mm hose and take it with you to HD or Lowe's, and you might something that fits even better without need to grind. Use of a curved hose adapter reduces the stress on the mounting of the Kreg dust collection shroud which is fairly easy to to pop loose. When the Kreg jig with dust collection shroud is used with a CT 22 at full power, nearly all of the drilling chips are captured at the source. Removal of the chips as they are created also reduces stress on the special stepped drill bit used with the pocket hole jig and enables drilling the holes using a faster feed rate. The more I use the Kreg jig, the more I like it for assembly of components where the pocket screw holes will be hidden from view. I used the Kreg jig later to drill pocket holes on the top and bottom panels of the Bookcases and TV Cabinet; these helped draw the Domino tenon joints together.

I made the door frames from 5/4 oak stock (true 1 inch thick). The pieces were cut to exact length with square ends on the MFT using the flip stop supplied with the MFT 1080. Each end of each door frame rail and corresponding top and bottom ends of the stiles were mortised with the Domino machine for a single 10x24x50mm Domino tenon at each joint. After glue up, I clamped the door frames to the top of my MFT using Festool Clamping Elements (Item

#488040 and / or F-style Quick Clamps (Item #491594) and sanded them flat using my RO 125 followed by my ETS 125 on top of my MFT. After assembly of the door frames, I made another dry fit check of the entire Console, this time with the edging installed on the base panel. In one of the near final dry fit checks I installed the hinges to help ensure proper clearances before applying any finish coats. On the backside of the door frames, I routed a rabbet using a bottom bearing bit and hand chiseled the corners to accept later installation of the decorative glass panels, and ordered the glass. The glass was not installed until after the Console and door frames were completely finished.

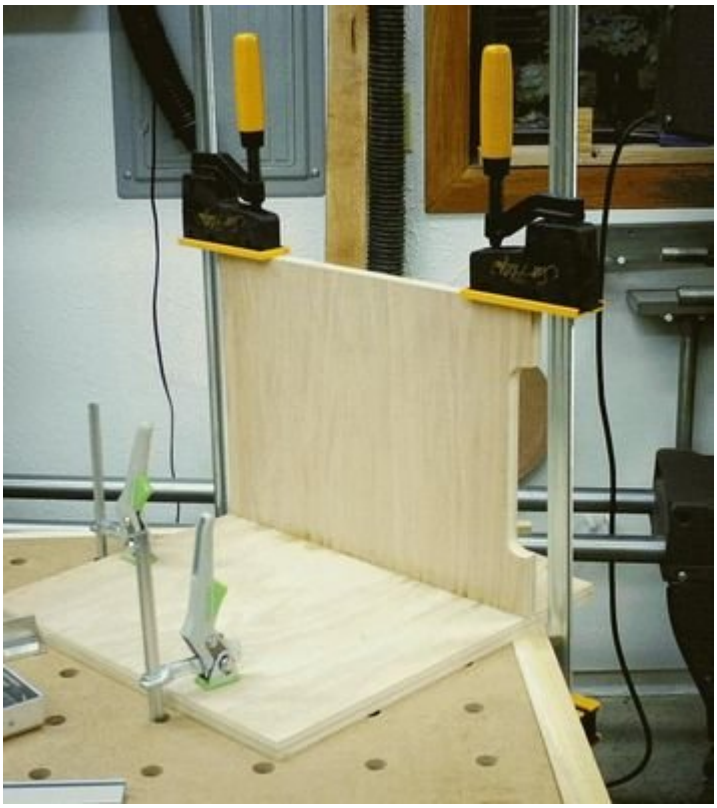
Sorry, but I could not find a photograph of the bare door frames showing the back side. There is one later with the glass in place under the section entitled “Installation of the Glass Panels in the Doors of the Console.”

After I finished drilling the shelf pin holes, and was satisfied with the dry fit check, I began to assemble the Console components with glue. I glued the front and rear edging strips onto the sides and other plywood panels and shelving. Then where needed I scraped and then sanded the edging and panel surfaces flush, using mostly my ETS 125 and LS 130 sanders. For most of this work I preferred the fine degree of control provided by the LS 130's linear motion, which is much like hand sanding except much faster, and with less airborne dust. The LS 130 is certainly not an aggressive sander compared to others in Festool's product line, but if you want to remove material a little more aggressively all you have to do is hold the sander so its back and forth motion is at an angle to the grain direction. Then return to sanding with the grain to remove those cross-grain scratches. Not once did I cut through the very thin oak veneer of the plywood. I was concerned about this as I had never before built a furniture project using veneered plywood panels for the main surfaces; I was a traditionalist who glued up the needed panels of solid wood boards.

An additional advantage of the LS 130 for sanding applied edging flush with the surface of a plywood panel is that it eliminates the risk of creating deep sanding scratches across the grain the remnants of which only show up when you apply a pigmented stain. I learned this the hard way even after sanding with my ETS 125 through 220 grit, and had to scramble to wet sand out such scratches while staining some of the components of this Entertainment Center. That was a lot of extra work and a waste of sandpaper (which quickly loaded up due to the wet stain) that I would rather avoid in the future; besides, the very thin veneer can be easily cut through when trying to remove scratches created by a rotary or orbital sanding machine by further use of a rotary machine with fine abrasives.

I glued the short shelves to their respective partitions before gluing these sub-assemblies to the rest of the Console. As can be seen in the photograph below, the MFT proved very useful for this task because I could draw the glued Domino joints together by tightening the bar clamps the bottom jaws of which engaged the bottom edge of the side rails while keeping them perpendicular to the partition panels. [Remember that I am working alone and don't an extra pair of hands to help with these tasks.] Even though I sanded the 5 mm Domino tenons and chamfered their ends, a lot of force was required to seat them fully close the joints between the components being joined. Most of my construction used original Domino tenons sold under Item #493296. Despite spending a lot of time sanding their faces and edges, they were still a very tight fit. Festool has changed the dimensional specifications for their 5 mm Domino tenons; the reduced size ones are sold under Item #494938 and are significantly easier to put into a Domino mortise. But I did not have any of the new Item number until I was nearly

finished with this entire Entertainment Center. I found this out when I needed more 5 mm Domino tenons to complete this Entertainment Center. This Domino tenon fitment problem seems to be limited to the 5 mm Domino tenons; the 10mm Domino tenons were a "tight slip fit" during dry fit check and the joints not difficult to draw together with clamps or a mallet when gluing up the door frames.



After completion of these sub-assemblies, and final sanding, I applied stain and finish coatings to them, prior to final assembly of the Console. There were so many components that I cannot show them all in a single photograph. They were strewn all over my shop to dry between applications of additional coatings. If you continue reading through my story, you'll learn how I somewhat changed my order of work when making the Bookcases and again when I made the TV Cabinet that rests on top of the Console.

Chapter IV - Finish Schedule and Notes

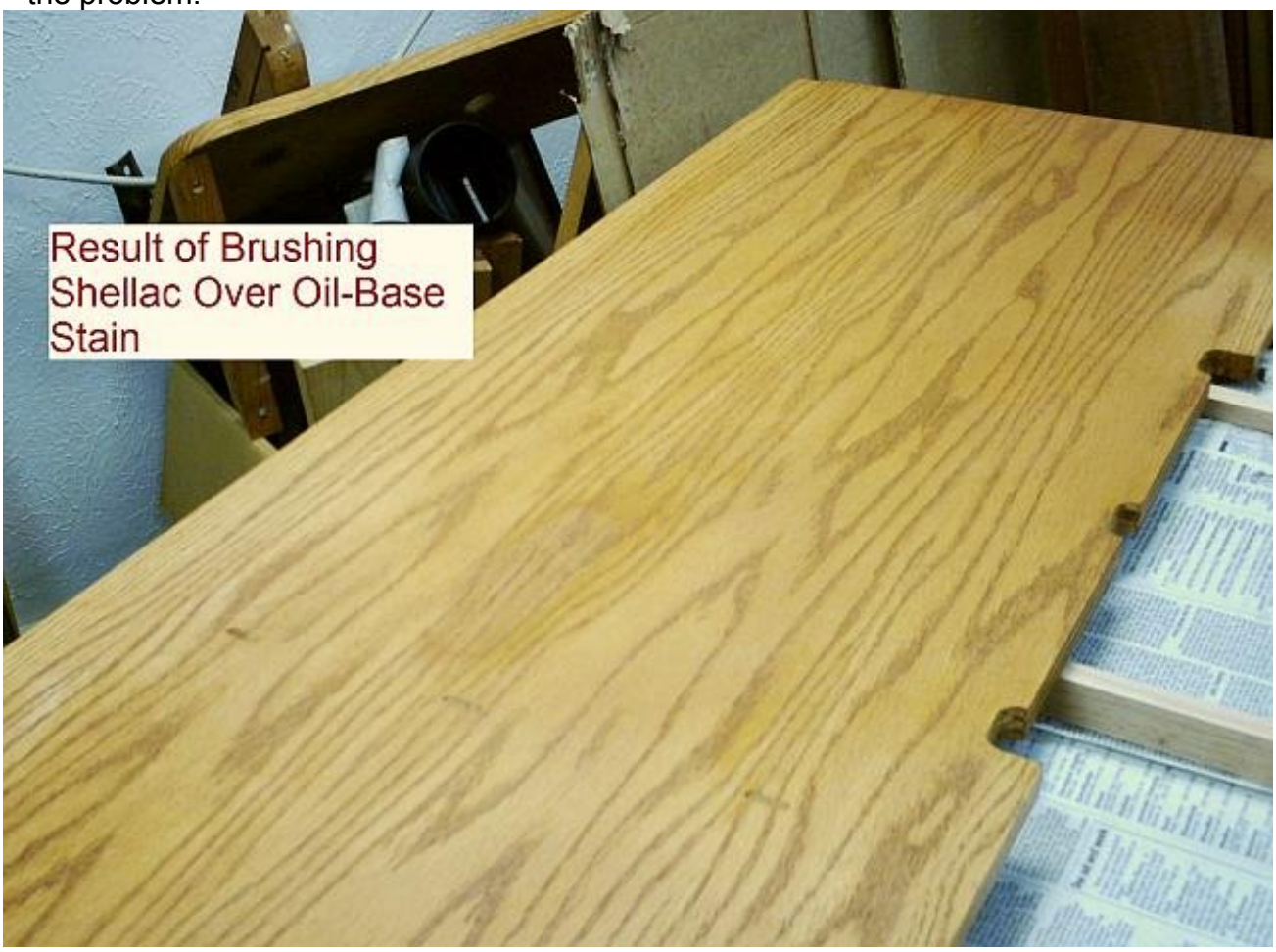
Finish System, Problems and Solutions

The finish schedule I followed for nearly all components of this Entertainment Center is listed below together with some notes based on what I learned while making this Entertainment Center. The finish system I used is a combination of solvent based and water based coating materials, applied using a combination of brushing, wiping and spraying.

1. Sand through 220 grit. I used Festool sanders and Festool Brilliant abrasives for 180 and 220 grit, for lower grit numbers I used Rubin interchangeably with Brilliant.
2. Vacuum all surfaces to be finished using the brush attachment on the shop vacuum machine. I also vacuumed every surface I could reach in my garage / shop to reduce creation of airborne dust during later spray applications of coatings. If possible, I recommend applying the finishes in a different room than was used for machining and sanding the pieces to be finished. I did not have that option, although for some of the finish applications on some components of the Entertainment Center, the weather permitted me to apply the spray coatings outside. Doing that has its own set of associated problems, in my shop setting including rain, very high humidity, insects landing in the wet finish coat, and due to my lot having many large trees that border my driveway, leaves and pine needles landing in the wet finish coat.
3. Wipe all surfaces to be finished with a clean, dry microfiber cloth. I used the same gold-colored cloths I had purchased from Griot's Garage a few years ago for use when hand polishing my cars. They are reusable indefinitely provided you properly wash them to remove accumulated dirt and dust. There are differences in quality among brands of microfiber cloths and different fiber types, diameters, lengths and numbers of fibers per unit

area. Do not use fabric softeners and launder them separately from other items to avoid lint.

4. Apply wash coat of 1 lb cut alcohol base shellac. I used Zinnser's Seal Coat and diluted it approximately 1 to1 by volume with denatured alcohol. This was applied with a brush.
5. Apply oil-based stain. I used General Finishes wiping stain, Pecan color. This product is very slow drying even under ideal conditions of low humidity and temperatures around 75 degrees Fahrenheit. For the Console, I applied a second coat of the same stain a couple of days after the first. There did not seem to be much effect on the depth of color, although it did turn out slightly darker in appearance in some lighting conditions than some of the Bookcase components on which only a single coat of stain was applied.
6. Apply wash coat of alcohol base shellac. I used the same 1 lb cut Seal Coat as above. This is where I ran into a major problem. **Do not brush this coat.** As I brushed on the shellac, the solvent apparently began to attack the binder used in the oil-base stain, and the stain started to smear with my brush strokes, being removed in some areas and deposited overly thick and dark in others. Eventually, after some quick removal of the excess, and some quick restaining and touching up of the lighter areas and blending efforts, I repaired much of the blotchiness I had created. If you look carefully in the below photograph which shows the top surface of the bottom panel, you will see what remained of the problem.



I entirely avoided repeating this problem with the stain when finishing other components by spraying a light mist coat followed by a slightly wetter coat of the 1 lb cut SealCoat when finishing the rest of the this Entertainment Center.

7. Apply wet coat of Target Coatings' Oxford Brand Amber color water-based shellac. No dilution was used. I simply poured it through a paint strainer into the cup of my Fuji HVLP spray gun.
8. After the water-based shellac is dry, inspect the surface. Respray with water-based shellac if coating appears rough or insufficient. If the first spray coat felt rough or appeared to entrapped sanding dust or raised wood fibers, I lightly sanded the coating with 320 grit wet or dry (black silicon carbide) sandpaper to knock down these high spots.
9. If you sanded the shellac coating, wipe it down with a microfiber cloth.
10. Apply a wet coat of Target Coatings Oxford brand vinyl sanding sealer. This material was rather viscous as packaged by the manufacturer. Generally I slightly diluted it (<10 percent by volume) using distilled water, or water collected by my basement dehumidifier. Tap water is likely to contain minerals and chemicals which may chemically interact with Oxford's water-based products. The main reason for diluting this sealer is to help avoid the coating bridging over the pores of the red oak instead of sinking into them. I wanted to partially fill the pores with the finishing coats. I did not want them completely filled since other commercially manufactured oak furniture in my house does not have fully filled pores. Let the coating fully dry. Under good conditions of moderate temperatures and 50 to 60% humidity it will likely only take about one hour.
11. Inspect the dried coating and recoat with sanding sealer if you think it necessary. Again, you are looking for spot with defects compared to the areas immediately surrounding them.
12. After the sanding sealer coats have fully dried and hardened (I allowed at least a couple of hours), sand the surfaces with 320 or 400 grit wet / dry abrasive. How far this coating is knocked down by sanding will significantly influence how much the pores appear to be filled in the final finish. The more this seal coat is knocked down, the smoother and less open porous the final finish will be. If you want the pores filled, apply a clear filler such as Crystolac brand or equivalent after applying the stain. I did not use any filler when finishing the Entertainment Center shown in the accompanying photographs.
13. Wipe with microfiber cloths.
14. Apply wet coat of Oxford brand water-based gloss lacquer and let dry. Apply another wet coat if desired. These are relatively thin coats compared to the sanding sealer. Whether or not additional coats of lacquer are advisable is dependent on many factors. One of the most important factors is the technique of the spray gun operator . I have found that I can adjust the spray gun so that I get an even thin wet coat, then hand that gun to another person who will have problems achieving the same result due to holding the gun at a different distance from the surface being sprayed, holding the gun at a different angle or moving the gun at a faster or slower speed. I recommend experimenting on the underside surfaces of a workpiece or some cardboard or a sheet of paper to get a feel for how operator technique and spray gun settings influence the result. I use gloss lacquer for the first of the final finish coats because it has better clarity and usually better abrasion resistance than the semi-gloss or satin coats that may follow.
15. Inspect finish. Knock down any dust bumps with 400 grit wet or dry sandpaper if the surface bumps can be felt with your bare hands.
16. Wipe with microfiber cloth.
17. Apply wet coat of Oxford brand water-based semi-gloss lacquer. Let dry. Inspect finish. If clean and smooth, proceed to next step.
18. Apply second wet coat of Oxford brand water based semi-gloss lacquer. Let dry. Inspect finish. If smooth and free of defects, you are done.
19. Let the finish continue to dry and harden. Several days are required before the finish fully dries and cures and reaches its full hardness and resistance to physical (abrasion) and

chemical substances (spills). I usually allow at least one full week before placing items on the recently finished surfaces.

20. Take a well-deserved rest and admire your hard work!

Notes regarding the above listed finishing schedule and materials.

A. Red oak often contains significant amounts of tannins (tannic acid). Many of Target Coatings water based products are highly alkaline, and potentially reactive with the tannic acid in the oak. For this reason, Target Coatings website recommends using oil-based stain and sealing that stain with solvent base dewaxed shellac (which SealCoat is) followed by a coating of Target Coatings water based shellac which they consider to be a universal sealer compatible with all of their other coating materials.
B. If you realize you have applied too much finish, you can simply wipe it away with a dry cloth or even a paper towel, with any of these water based coatings. A run on a vertical surface is obviously too much finish in a single coating. So is an area in which the coating appears overly thick as evidenced by a thick wet, shiny layer that is milky in appearance. After wiping the excess away, let the remaining finish dry, and later recoat. This is an advantage of Target's water-based coatings (and maybe other brands as well) that does not exist with solvent based lacquers I have used in the past. With those solvent-based lacquers you generally had to wait for the coating to dry, or at least begin to harden (gel), then carve it away with a small file such as those sold by auto body paint suppliers.

Installation of the Glass Panels in the Doors of the Console

The glass used in the doors was ordered from a local glass supply house, but they in turn had to order a sheet of the specific type of glass that was chosen for the doors of the Console. This glass has a relative smooth front face, but the back face is very bumpy due to the presence of many small, rounded mounds of glass. It is called "Pebbled Glass" by some vendors. Viewed from the front side from a distance, it looks similar to some seeded glass materials. It is available with differently sized "pebbles,." and in different thicknesses. I wanted to use tempered glass for improved safety, but the glass dealer informed me that tempered pebbled glass was not available in the lesser thicknesses suitable for these doors; it was available in 3/8 inch and greater thicknesses. Anyone with children or pets should use tempered glass for improved safety.

The vendor cut the glass slightly longer than the dimensions I had specified, and by the time it arrived I had already completely finished the door frames. To shorten the panels, I hand ground them using a small metal disk with ~60 grit diamond bonded in nickel on it flat faces, keeping the surfaces cool and lubricated by frequently wiping them and the diamond disk with a sponge dipped in water. I purchased that disk at a Woodworking Show for use in touching up some carbide masonry drill bits but have yet to use it for sharpening. But I have used it several times to ease the edges on other pieces of cut or chipped glass. Installation was straightforward once I finished removing about 1/16 inch from the glass panel, which took me about 30 minutes.

Lesson learned: Always have components such as these glass panels on hand before making the furniture components. It will save you a lot of time and frustration doing rework.

To install the glass, I simply laid the door frames down flat, inserted the glass panels, then

applied a few short length "spot beads" of DAP's 50 year life Clear Acrylic Latex Caulking spaced around the inside edges of the frames where they meet the glass. This caulk product is milky when applied but turns clear within a day. I left the doors lying with their front faces down flat for a day, then installed them on the Console. After the caulk dried, it is almost undetectable from the outside and even the inside unless you come close and study the doors trying to determine what is holding in the glass. The caulk spot beads hold the glass very firmly; there is no rattling, yet the resilient bond allows relative expansion and contraction movement between the door frame and glass. If I ever have to or want to remove the glass panels, all I have to do is cut the spot beads with a utility knife, which can be done without touching the finish on the insides of the rabbeted oak frames.

Below is a photograph of showing the "spot beads" of acrylic caulk serving as a glass panel retainer. Sorry for the poor quality of these photographs! In the first photograph below, the pieces of masking tape identify the locations of the "spot beads."

In the photograph below, the upper right corner of the text box is pointing to the "spot bead."

They are hard to see even when viewed in person at close distance.

Chapter V

Building the Bookcases

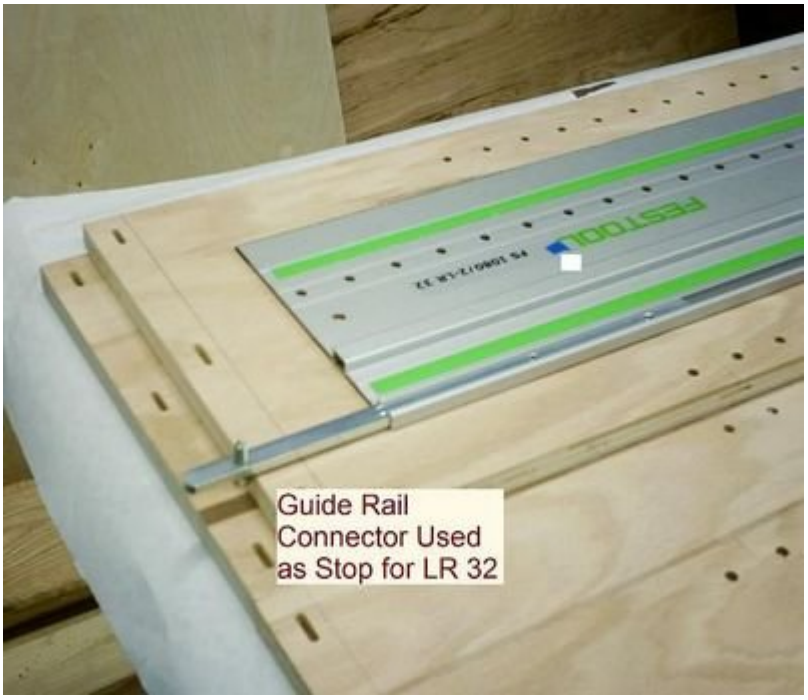
The panels and associated edging strips were cut and mortised for 5 mm Domino tenons using my Domino machine as described above in regard to the Console. Before gluing on the edging strips, I drilled two rows of 1/4 inch shelf pin holes in the inside surface of each side panel, and two rows of holes in each side of each center panel. Due to the nearly 7 ft length of these panels, I needed to "walk" the 42 1/2" inch (1080 mm) LR 32 Hole Drilling Guide Rail lengthwise along the panel to complete a continuous row of evenly spaced shelf pin holes. This was fairly easy to do by attaching a non-holed Guide Rail to one or both ends of the LR 32, and using pencil marks and my router with 5 mm bit installed as a locating pin. A significant additional design requirement of the customer (my wife) was to enable the uppermost level of removable shelf panels to be installed such that their elevations would exactly match that of the bottom cross piece of the TV Cabinet (yet to be built) when installed resting on top of the Console, to provide the appearance of a horizontal row of near cubical cubby holes for her to place art items.

The center vertical panel of each of the pair of Bookcases is shorter than the side panels. The center panel extends vertically between top and bottom cross panels, subdividing the Bookcase into two narrow columns to be fitted with short shelves. Getting the shelf pin holes aligned at the proper elevation in all four panel faces presented an additional challenge to me. A simple Bookcase comprising two upright sides with shelves extending between the sides would have been much simpler. The actual elevation of the shelf pin holes in the assembled Bookcase was going to depend not only on accurately measuring and cutting the lengths of the

center and side panels, but also the actual thicknesses of the top and bottom cross panels, and whether they were truly flat and straight. In hindsight, it would have been better to have first built up the base panels with sub-frames, thus making them as flat-topped torsion boxes and dry fit checked and marked the desired shelf pin holes elevation on the center panel before drilling shelf pin holes in it. In practice, I added the reinforcing sub-frame members with pocket screws after the Console and Bookcases were otherwise fully assembled with glue.

But what I did worked out well. My solution was to measure and layout pencil lines extending across the panels to identify where the plywood cross panels (horizontal in the finished, installed Bookcases) would intersect with the inside surfaces of the side panels, and where the shelf pin holes should be drilled. If I had had the space available, I would have laid all three panels for each one of the Bookcases side by side on a table or the floor, with the center panel positioned at the correct elevation relative to the tops and bottoms of the side panels, and when in that alignment marked reference pencil lines across all of them for use in getting the shelf pin holes in the desired locations. None of the flooring in my garage is truly flat, and my driveway is steeply sloped from the street to the house and attached garage with compound crowned contours near the garage. The slope is great enough that a flat board placed on top of those small plastic painter's pyramids often slide off them or pull them over. And it was now late Fall season and the weather was seldom good for working outside. Because I did not have a large flat floor or table space available, I stacked the panels for one Bookcase on my MFTs and auxiliary table, marked their front edges and then transferred those marks into pencil lines extending fully across the faces to be mortised with the Domino machine and to be drilled with my OF 1400 and LR 32 with Hole Drilling Set using a 1/4" straight bit. I did the same for the second Bookcase. I used my Woodpeckers precision carpenter's square to draw the pencil lines, always referencing from the front edges of the panels. Because the distance of the shelf pin holes from the top ends of the panels was set arbitrarily to enable adjusting the shelves to create the appearance of a stack of cubes, the Linear Stops supplied with the LR 32 Hole Drilling Set were not used -- those stops are designed to place the LR 32 Guide Rail exactly either 16mm or 32mm from the pin in the Linear Stop. Instead, I substituted a Guide Rail Connector (Item #482107) and replaced one of the set screws with a 6mm machine screw to create an Adjustable Linear Stop for the LR 32 Guide Rail that could be set wherever I chose. This enabled me to set the holes at whatever distance I wanted them to be from the end of the panels. I relied on these Adjustable Linear Stops to position the LR 32 Hole Drilling Guide Rail relative to the top edges of the panels, using the pencil lines I earlier made to confirm the locations of the holes.

Shown below is the LR 32 setup I used with my Connector made into an "Adjustable Linear Stop." I used a small piece of blue masking tape to identify the starting and end points of my rows of shelf pin holes relative to the top end of this central divider panel. When retouching this photographgraph using IrfanView, I inserted added the little white square to help the reader locate the piece of blue tape.



I did not need to use the Edge Stops from Festool's LR 32 Hole Drilling Set (Item #583290) to set the distance of the shelf pin holes relative to the front and back edges of the Bookcase panels. I eyeballed the position relative to the front and back edges of the panels. However, while doing this, I made one mistake that cost me some time after final assembly. One of the front rows of shelf pin holes was not set back sufficiently from the front edge of the panel. At that time I was thinking that placing the shelf pins very close to the front and back edges of the upright panels would provide the widest pin spacing and thus best support for the shelves, which is true and would not have created any problems if the shelves were simply flat panels of even thickness throughout. I did not realize this oversight until after I had added the 1" thick edging on the front of the 3/4 inch plywood panels forming the short shelves which had fit well during a prior dry fit check. I used various widths of 1" stock scraps for this edging, glued it on, and trimmed the back plywood edges of the shelves to make them the needed overall depth. When I went to trial fit them again, the edging on a few of them rested on the edge of the front shelf pin instead of the allowing the shelf pins to bear fully on the thinner portion of the bottoms of the shelf panels. Because of some variation in setback distance of the front rows of shelf pin holes and front to back dimension of the edging on the front edges of the short shelves, shuffling their positions solved most of the interference problems. A little relief cut or grinding of the spade headed shelf pins solved this problem for the rest of the problematic shelves. Alternatively, I could have carved away a slight amount of the back edge of the offending front edging strips, but I did not want to remove the finish, and the from shelf pins are hidden from view when the shelves are installed.

The side panels were mortised with the Domino machine, using the same template used to mortise the side panels of the Console. Because the Bookcase panels are 12 inches wide (depth direction in the finished bookcases), only three mortises were cut in each front to back row. (The side panels and partition panels of the Console each had four Domino mortises in each row). As when making the mortises in the panels of the Console, the template was always referenced relative to the front edges of the Bookcase panels.

The accuracy of my method of marking the elevations of the Domino mortises and template method was confirmed when I cut the mortises for the lowest level of short shelves which are secured with glue and Domino tenons. I set the plunge depth on my Domino machine shallower than normal in the hope of not cutting all the way through the center divider panel and cut the mortises from each face of the center panel using the same template used to cut the mortises in the upper and lower full width cross panels. But the core veneer layer partially tore out and I could see that the mortises made from opposite faces using the marked lines on my template were perfectly aligned! I pushed a 5mm Domino tenon through each one to confirm that was true. If I built another case with a similar center divider panel, I would clamp a block of scrap to one side of the panel or lay it on some scrap to support the exit side of the mortice cut and plunge the Domino machine to cut the mortice all the way through the panel in a single step.

Before assembly of the Bookcases, I used my Kreg jig to drill pocket holes into the top surface of the top cross panel and into the bottom surface of the bottom panel, taking care not to place a pocket hole where a Domino mortise was located. The main purpose of these pocket holes was to help draw fully together the components being glued up. Because the front and rear edging strips are offset 1/4 inch relative to the plywood panels forming the sides of the Bookcases, and the size of these cases, it is difficult when working alone to hold all the pieces being glued together, the long bar clamps and wooden cauls. The pocket screws, especially those placed near the center of the width of the panels helped reduce the need for cauls.

I also tried a somewhat different order for the finishing steps relative to assembly when building the Bookcases. Because I ran out of room in my shop to set all the pieces of the console to dry between finish coatings, I decided to follow the finish schedule only through application of the stain layer before assembly, then apply the rest of the finish coatings to the assembled cases since they would take up much less shop surfaces and spaces. And I could proceed with construction of the TV Cabinet while waiting between coatings. And the weather had turned decidedly to winter so I needed to do everything, including all of my spraying inside the shop, and pick up my pace if I wanted to get done before Christmas.

Assembly of the Bookcases

Due to the center standard and short shelves at at elevation 24 inches above the bottoms of the side panels and use of Domino tenons, the Bookcases had to be assembled in stages. Below is a photograph showing partial assembly of one of the Bookcases. Both the base cross panel and the lower short shelf panel fitted with Domino tenons are being glued up. I shortened the Domino tenons and inserted them first into the end of the short shelf to ensure that both short shelves would be equally secured to the center panel. Alternatively, I could have used a full length 5mm Domino tenons and made the mortises deeper in the edges of the short shelves that were to be joined to the center panel. That would have been faster than what I did. I chose not to do that because the next deeper incremental stop was 20mm, which would have left less of the tenon projecting into the center panel than I wanted (Festool's 5mm tenons are 28mm long). So instead, I left the Domino set at 15mm plunge depth and trimmed the six tenons needed for each bookcase. In the interest of safety, I would have used my bandsaw, but my shop was so cluttered at this point that my bandsaw was not very accessible and my MFTs were in use for the glue up and assembly as well as with my Kreg jig. So I set my Domino machine on the least depth setting and plunged a few mortises into the side of a scrap of 3/4 inch plywood, then inserted a Domino tenon in each and trimmed them to uniform

length on my table saw.

Note in the first photographgraph below only the short shelf is being glued up to the side panel which is on the bottom in this photographgraph. The other Bookcase components are in position merely to ensure that the center shelf is squared up and correctly located. I made most of the mortises slightly wider than the width of the 5mm tenons so the pieces could be adjusted if and as needed during assembly. Clamps were used to pull the components into correct position as needed.

In the photographgraph immediately below, the top panel is being added and glued up to the sub-assembly shown in the photograph just above.

Shortly after closing the joints with the help of a mallet and the bar clamps, I inserted the pocket screws which helped to pull the center of the side panel tight against the cross panels. Thereafter, I added the remaining short shelf and the other side panel, closed the joints with a mallet and the bar clamps, and inserted the remaining pocket screws. This part of the project was very stressful because of the number of spaced Domino tenons (3 sets of 3 with nearly 7 feet between the top and bottom cross panels) to which glue had to be quickly applied, the tenons inserted, glue applied to the protruding stub tenons and all confronting surfaces.

The edging on the front of the center panel is also mortised at both ends and joined with Domino tenons to the edging on both the top cross panel and the bottom cross panel. Domino Cross Stop (Item #49348) was used to cutting the mortises in the ends of the edging strips. This accessory is quick and easy to attach to the Domino machine and also quick and easy to adjust to fit the narrow workpiece to be mortised in its end. I did not have any reason to offset any of the mortises in the ends of the edging strips, but that would also have been easy to do because the Cross Stop has easy to read and use scales molded into the movable components that contact the sides of the workpiece to align the Domino parallel to the length of the narrow workpiece. With the Cross Stop installed and adjusted to the width of the narrow workpiece, the workpiece is captured within three surfaces assuring good alignment for cutting the mortise in a direction parallel to the length of the workpiece, the Domino machine cannot jump laterally when plunging.

To facilitate installation of the edging on the center panel (which had to be installed by a combination of rotation and lengthwise sliding movement because of tenons protruding at right angles on the back surface and bottom end) and slipping the tenon into the mortise in the edging of the bottom cross panel, I extended the width of the two mortises nearest the bottom of the center panel which was already joined to the bottom cross panel. Since I had not yet secured the top cross panel to the center panel, I could pull on it to create enough space for insertion of the tenon joining the front edging of the top cross panel and the front edging of the center panel. Then the second short shelf was joined to the center panel. And lastly, the other side panel was glued on. Thus, mine was a slow, sequential method of assembly with many dry fit checks. Lifting and positioning the second side panel and getting all nine tenons started

into their mortises and drawing them evenly home proved somewhat of the challenge. When I tapped one corner, another earlier started corner would pop out, and if I drove the first corner in deeper, thus canting the panel, I couldn't get the rest of the tenons to hit their mortises. But I finally got it together. These problems would not have existed if I had had a helper who could have assisted in applying glue to the many Domino tenons and lifting and positioning the many mortise and tenon joints at once, and would have been less if I had done this assembly work on top of a solid table. I assembled this Bookcase on top of a old hollow core door laid across a pair of sawhorses. That surface would bend and rebound as I struck the panel with a mallet, rather than the joints being driven closed. A rigid support surface that did not bounce when struck by a mallet would have been much better. Since I had applied glue to all confronting surfaces and the tenons, and had to get the pieces to together quickly, I slid the assembly to and fro along my makeshift table so my mallet strokes would be directly above one of the sawhorses. That worked, but those were intense moments I'd rather avoid. I came very close to ruining a lot of hard work. Now I much better understand why people like Norm Abrams apply most of their trim using a continuous slot on the panel edge, biscuits for alignment and a finish or pin nailer. But I don't like using nails in furniture, and don't own a pin nailer. The backs of each piece of this Entertainment Center are attached with small screws with an antique bronze finish in pre-drilled, countersunk pilot holes.

Lessons learned: Get someone to help when gluing up complex assemblies, especially when the distance between the joints to be brought together is more than your arms' reach. Support the project being assembled on a solid surface that won't bounce when you use a mallet to drive the mortise and tenon joints fully closed. Get Domino tenons that are not too tight fitment, particularly for application of trim pieces.

CHAPTER VI

Construction of the TV Cabinet

The design of the TV Cabinet had to be a bit different from that of the Bookcases for several reasons. Design of the TV Cabinet presented several problems not existent in the design of the Console or Bookcases. The TV Cabinet is 52 inches wide, so the back panel could not be cut from a single sheet of 1/4 inch oak plywood as were the back panels of the Bookcases while still keeping the face veneer grain running vertically. Some way of getting the electrical cables through was needed, and ideally there would be no bottom panel or front cross piece interfering with the appearance sight lines when the completed TV Cabinet was set on top of the fully finished Console at final installation in the room. Another requirement was to enable each of the four pieces comprising this Entertainment Center to be able to be used independently of one another, if desired by myself or a future owner, e.g. someone not having ten ft of wall space to fill. I drew up and considered several different designs before settling on what I actually built. I purchased a few different types and sizes of grommets expecting I would need to use some of them, including one of those wide oval-shaped grommets often seen on computer desktops. In the end, I didn't use any of them in the TV Cabinet, and only one in each Bookcase to facilitate installation of speaker wires. (My current speakers have rather large molded on plugs with at least four electrical pins in each.) I think I achieved my design goals. At the bottom of the back edge of the TV Cabinet, there is a cross member of 1 inch thick x 3 1/4 inch oak. In the final design that I actually built, it's important this bottom cross member be resistant to bending to keep the front edges of the side panels from flexing

out of their intended vertical planes. I would have made this cross member of thicker wood, but the shallow depth (14 inches front to back outside dimensions) because my customer (my wife) wanted the TV Cabinet to be as thin as possible to house the flat screen TV, and she wants me to add doors later to hide the TV when not in use. The base of the TV is 11 1/2 inches front to back, so I did not have much room to spare. In the center portion of the lower edge of that bottom cross member of the TV Cabinet, I cut a recess about 1 inch high by 16 inches wide with my jigsaw, then used my OF 1400 with a 1/2 inch radius quarter round bit to round over the edges that would later be contacted by the electrical cables. The electrical cables are routed over the back edge of the top of the Console and through this cutout region of the bottom cross member of the TV Cabinet. Rounding over edges of the recessed area also reduced the bend radius of the electrical cables during their installation. I also rounded over the top inside edge of this cross member using a 3/8 inch radius bit.

The 3/4 inch thick plywood panels and edging strips were cut and mortised using my Domino machine as described above in regard to the Console, and the Bookcases. After mortising the side panels to join the upper (top) and lower (bottom) cross panels, the front and back edging strips were glued to the side panels. A dry fit check was then made to enable marking the exact locations of the pair of short vertical partitions that extend between the upper and lower cross panels of the TV Cabinet, and the approximate lengths of the front edging strips for the cross panels, which are shorter than the panels themselves due to the overhang of the front edging strips towards the inside of the TV Cabinet, as in the Bookcases. I made two sets of spacer blocks from lengths of scrap to ensure the vertical panels would be properly located during the dry fit check and markup. The dry fit assembly was then taken apart and Domino mortises cut into the confronting surfaces of the upper and lower cross panels for joining to the vertical partitions. In the next dry fit check, with dry Domino tenons installed in all the mortises, I again checked and marked the front edging pieces, re-cut them to final length and confirmed the locations of the mortises to be cut into side faces of the front edging strips. I then cut the mortises in the edging of the side panels *in situ* using my Domino machine with its fence set at 90 degrees (so the face of the fence is parallel to the bit) and resting on the front face of the edging and another strip that I clamped flush with the edging strip to provide additional support for the Domino fence. I was pleasantly surprised how well that simple technique worked. Without the extra support block clamped on, registration of the Domino machine with its bit axis truly perpendicular to the face to be mortised was not certain. I could rock the tail end of the Domino machine up and down and not easily tell if the fence was flat on the narrow top surface of the edge strip to be morticed. I could not use the extra fence support piece (made of black plastic) that is supplied with the Domino machine and attaches to the bottom of the Domino machine for these mortices because the crosswise plywood panels positioned under the locations where I wanted to place these mortises while the cabinet was dry fit assembled for this work. I set the depth of the Domino fence to place the mortises in the center of the 1 inch thick edging for these mortising operations.

The 1 inch x 1 inch front edging on the lower cross panel of the TV Cabinet is flush with the top surface of the panel but overhangs the lower surface by 1/4 inch, as does the edging on the shelves, and the bottom cross panels of the Console and Bookcases. Thus, the position of the mortises into the side surface of the front edging on the side panels does not correspond to the thickness centerplane of the plywood of the lower cross panel.

The front edging on the top cross panel is 1 inch thick x 1 1/4 inch wide and is centered on the upper cross panel, as it is on the Bookcases. I centered the end mortises on the ends of the

front edging on the top cross panel.

After trimming the edging pieces that go on the upper and lower cross panels, the edging for the lower cross panel was glued with Domino tenons to the lower cross panel (without any tenons in its ends) while the TV Cabinet was dry assembled to assure correct placement. Then the Console was disassembled, the bottom panel edging sanded flush with the top surface of the panel. The front edging on the top cross panel was similarly fitted, as were the edging pieces on the vertical partition panels, to assure close fitting joints at the ends.

As with the Bookcases and Console, the TV Cabinet was assembled in stages with several dry fit checks to ensure correct lengths and placement of the Domino mortises and tenons in the correct locations. A specific sequential order of assembly was needed because each of the confronting ends of the front edging is joined to another piece of edging with a Domino tenon. The two following photographs show how I assembled the centered vertical ~4 inch wide x ¾ Inch thick board that divides the lower back portion of the TV Cabinet. This board extends from the bottom of the back edge of the lower cross panel to the top of the bottom cross member (stretcher) that joins the two side panels together. Two 5 mm Domino tenons were used in each of these joints. To reinforce the joint of this centered back board with the back edge of the top cross member, I glued (with Domino tenons) a strip of solid oak onto the back edge of the lower cross panel before ripping it to final width and cutting the mortises.

In this photograph and the one just below it, the TV Cabinet is lying with its front face down on the table, so the framework into which the five pieces of 1/4 inch plywood comprising the back panels later will be fitted is facing up.

The photograph below shows more of the lower end of the clamp and cross member arrangements. Note the use of some Systainers and wood block to support the bar clamp with the red clamp head. Again, a second person to help with this assembly would have been very welcome. To give you a sense of scale, the yellow and black bar clamps are 6 ft capacity, and the side panel in the foreground is 54 1/2 inches long (tall). The cross member with the cutout region for the electrical cables is at the far left in this photograph.

Note in the photograph above that the back edges of the panels and the boards that are clamped up are rabbeted. Five back panel inserts of 1/4" oak plywood were fitted into the recesses. I matched the grain pattern on the front surfaces as much as possible given that the overall width of the combined panels is greater than that of a standard 4 ft x 8 ft sheet of plywood. The large lower panels are exactly matched. The left and right upper panels are exactly matched to one another and the lower panels. The top center panel is not. The back panels were attached with countersunk antique bronze screws.

To protect the top of the Console on which the TV Cabinet was to be set, the bottom edges were covered with a layer of thin tan felt.

Making the Adjustable Glass Insert Shelves for the Bookcases

I made a total of fourteen shelves that could be used with the Bookcases, two solid panel shelves and twelve with a 10" x 10” (square) 5 mm thick tempered glass panel inserted into a recess the central region. After cutting the 3/4 inch plywood shelf panels of to size to fit between the uprights of the Bookcases, I glued on 1 inch thick edging of solid oak to the fronts, so that it was possible to arrange the shelves to give the completed Entertainment Center the appearance of a stacked array of near equal sized cubes. I did not use Domino tenons for the front edging, I simply glued the edging strips to the front edges of the plywood panels. That was a design constraint/specification at the beginning of this project, although a few days after installing the Entertainment Center, my wife decided on a different, unsymmetrical shelf arrangement as shown in the photograph below.

Good that I did not follow to closely the design of a Bookcase my wife had seen in a catalog that was the initial inspiration for the general design of this project! That wall unit had permanently fixed shelves, and the wooden strips that supported the bookcase shelves were visible under each shelf. (I thought that was ridiculous given the >$6000 price the manufacturer asked for it, even allowing that it was constructed of jatoba solids and veneered panels, but no lighting or decorative glass or glass insert shelving or decorative top valence, and straight sides on the side panels.)

Shown in the photograph below is the **Paired MFT 800s Setup** that I created and used for making the shelves with the glass inserts. In reality, making these shelves was similar to making a dozen small router table tops (I have not yet made a router table top!), except that the recessed areas were sized 10 inches by 10 inches rather than the common 9 3/4 inches by 11 3/4 inches used by several commercial router plate manufacturers, including JoinTech (iTools). This Paired MFT setup was easily put together done (providing both MFTs are either old or new style) using a pair of shop-made "Squaring Arms" based on those described by Jerry Work in his excellent MFT Manual linked on FOG. I made mine by laminating scraps of hard maple and black walnut on to a core strip 1/2 birch plywood. My usage here is different than the primary purpose taught by Jerry. The photograph is of two MFT 800s joined together

by the shop-made connecting arms that are spaced significantly further apart than is possible with Festool's metal MFT connectors (Item #484455). These shop-made connectors enabled me to setup the exact distance required to grip the lateral edges of the small shelf blanks.

Pair of Joined MFT 800s, view from topside.

Using this Paired MFTs setup, I wedged the short shelf panels one at a time into the gap between the edges of the tops of the MFTs and cut out the center region with a jigsaw. Then with a 3/8 inch straight bit mounted in my OF 1400 router and a 30 mm Festool bushing installed in its base, I routed out the center of the panel using my MFS 700 (Item #492611) as a perimeter guiding template. Then I changed out the bushing to the PC bushing adapter supplied with my OF 1400 router in which I had installed a much smaller bushing that would locate the bit much closer to the profile defined by the MFS frame, reset the depth of the router to correspond the 5mm thickness of the tempered glass inserts I had purchased, and routed a recessed rim around the cutout area in each panel to hold a glass insert. Note that I used both a 30mm Festool bushing aka Template Guide (Item#486033) for the full depth cuts and an Imperial (USA standard) inch bushing threaded into Festool's PC bushing adapter. Since this was not a laying project, there was no need to exactly match male and female cutting diameters. All that was necessary was to create a recessed lip around the cutout region of each panel to fit and support the associated glass insert. The combination of bushings I used created a lip width slightly greater than 1/4 inch wide, more than adequate to support the glass.

The next photograph is what could be seen when peering down through my MFS setup into a "Big Gulp" dust collection funnel attached under the connected pair of MFT 800s.

If you look closely in the photograph above, you will note the absence of the numeric graduations on the exposed top sides of the MFS. After setting the dimensions of the MFT, I intentionally flipped it upside down to avoid wear of the graduations which are painted on the MFS extrusions. I used the right angle brackets supplied with the MFS to aid in positioning the MFS template reliably and repeatably onto the panels being routed.

To set the size of the MFS template, I simply placed it over one of the panels to be routed which I had earlier marked with a pencil using one of the glass panels as my template. I adjusted the size of the MFS until the outside edge of the router bit touched my penciled line when the smaller diameter bushing was in contact with the inside wall of the MFS template. After cutting one of the panels and squaring the corners with a chisel, I checked the size of the recess with some of the glass panels. I learned they were not exactly 10 inches square as advertised so I set the MFS a little larger and proceeded to rout all twelve of the shelf panels to be fitted with glass inserts.

I learned that dust collection from my OF 1400 router through the topside mounted Dust Hood (Item # 492000) with a straight bit and bushing in the bottom is not very good. My Makita jigsaw has no provision for dust collection. I have Makita's extra cost dust collection adapter, but it is not very effective, and is a nuisance to mount and connect to any common or standard sized vacuum hose. (It makes you wonder what were their product designers thinking, or if they ever tried to use the product they had designed in its real world applications.) I was able to collect most of the wood dust by attaching a "Big Gulp" plastic dust collector funnel below the gap between the two MFTs to catch most of the sawdust as seen in the photograph below.

Pair of Connected MFT 800s with Dust Collector Funnel Bridging Gap between the MFTs

The “Big Gulp” rectangular funnel has a 4 inch outlet to which I attached a reducer and my Festool 36mm AS hose which I connected to Festool's Antistatic Y-Piece Hose Connector (Item #452898). I tried routing with a 27mm AS hose connected to my OF 1400 router and the other port of the Y-Piece Hose Connector for some of the panels, but later abandoned the upper 27mm hose because little debris was able to rise above the bit through the base of the router. This extra hose on top was not doing much good, but the Big Gulp funnel with bottom mounted hose was proving effective. I think the top hose was not very effective because the router was fitted with a bushing with an inside diameter barely greater than the outside diameter of the 3/8 inch bit that I used for all of this routing, which did not leave much area for debris chips and an air stream to pass upward through the base of the router, and the straight bit I was using had perfectly straight (axial) cutting edges and flutes.

I did not have any carbide straight bit long enough to extend through the bottom of the workpiece when the router was positioned on the MFT sitting on the workpiece. For this MFS guiding operation the bit needed to extend below the base of the router by at least ~5/8 inch (approximate thickness of the MFS extrusions) plus the 3/4 inch thickness of the plywood workpieces, i.e. a total of 1 3/8 inches. So I used an old Shopsmith brand 3/8 inch shank two-flute steel bit having an effective cutting length of about 2 inches. I changed the fully plunged depth setting of the bit once during routing of the full depth cuts to even out wear on the bit. The glue layers of the plywood cause a higher bit wear rate than the wood veneer layers.

The “Big Gulp” dust collection funnel was clamped by its inlet flange to the bottom of the side rails of one of the MFTs. A better way to hold the dust collection funnel in position would be to insert some square nuts (or Festool's elongated nuts like those used as stops when mounting the MFT cross cutting Guide Rail supports) into the T-slot channels formed in the bottoms of the MFT side rails, then bolt up a pair of thin wooden arms to hold the flanges against the bottom of the MFT side rails. This would also free up a couple of clamps for other uses.

Installation of Lamps in the tops of the Bookcases and TV Cabinet

I installed Tresco brand 12V PocKit Lamps with 20W Xenon bulbs in each compartment of the top level of the Bookcases and TV Cabinet. These lamps are available as kits having a transformer, wiring junction block and either two or three lamp units, and are a "plug and play" modular design. I used a hole saw to cut the needed 2 1/8 inch holes through the top cross panels of the cases and cabinet. After the holes were cut, I fed the wire leads for each lamp through the holes and installed the lamp housings by simply pushing them in from below (each lamp has small resilient fingers spaced around the housing which securely hold the lamps in the holes). Then I twisted a Tresco-supplied decorative ring onto the flanges of each of the lamp housings. I used a 2-lamp set for each of the Bookcases and a 3-lamp kit for the TV Cabinet. I also installed a Tresco touch dimmer unit and plugged the transformers into the 3-way outlet of the dimmer according to the Tresco instructions. Using screws, I mounted the transformers, wiring junction blocks and dimmer unit on the top cross panels of the Bookcases and TV Cabinet, and the touch pad for the dimmer on the back of the left (when viewed from the front) Bookcase so it can easily be reached from the left side of the assembled Entertainment Unit. The main power cord to the wall receptacle is also behind the left Bookcase. The power cord of the dimmer unit includes a rotary switch. I routed that power cord so that switch can be easily reached to de-energize the entire lamp system. The power cords of each of the transformers also includes a similar rotary switch, but as mounted these cords and switches are not accessible except from the top of the unit.

Based on my personal communications with Tresco's customer service engineer, Tresco cautions that the dimmer unit I purchased may not work properly around other electronic equipment due to lack of RF (radio frequency) shielding. And they are right, if my experience with the first dimmer unit is typical performance. The dimmer unit worked OK for a few hours, then seemed to develop a bit of a mind of its own, turning on or changing level when switching on other equipment. Through correspondence with Tresco's customer service engineer, I learned that Tresco is aware of this potential problem and that they are expecting delivery in the near future of dimmer units with improved circuitry and resistance to external RF. He informed me I could totally solve the errant dimmer behavior problem by connecting the Tresco transformers to a common household solid state wall box mounted dimmer control. Rockler sent me a replacement dimmer unit which seems to be working better, but not without some undesired, uncommanded stepping through its four states (off, low, middle and high power) when the remote control is used to switch on the Cable Box and TV simultaneously. I'm going to wait and try the revised Tresco dimmer before taking other steps to address this errant dimmer problem, if it persists. There is still an audible hum/buzz within about 2 ft, but the sound level it generates is less noise than the Scientific Atlanta DVR supplied by Warner Cable. But at least the touch pad can be used to adjust the brightness level or turn the lamps completely off.

Building the Valences

The valences which cover the tops of the fronts and sides the Bookcases and TV Cabinet were built and finished separately. After all four pieces comprising the Entertainment Center were installed, the valences were attached with screws inserted through a simple sub-frame made of strips of 3/4 inch plywood attached to the tops of the Bookcases and TV Cabinet with pocket screws. The valences were built by laminating two strips ripped from the same oak board to a center strip ripped from a single board of quartersawn lacewood (Australian silky oak). As much as possible, I kept together the oak pieces that were ripped from the same board so their grain patterns would to be matched on the upper and lower edges of the center strip of lacewood. Likewise, I selected and oriented the strips of lacewood ripped from the single board with the goal of emphasizing the many lighter colored rays that are the key feature in that species. Depending on how the board is cut from the tree, the rays can appear as rounded dots, tear drops, or extending "streams" across the width of the face of the board, and the backside of the same 3/4 inch thick board may have a very different appearance than the front. After trying many different orientations of the lacewood strips, I settled on trying to emphasize long "streams" of the lighter colored rays across the front faces of the boards. My wife and son also preferred this orientation; they said this ray fleck pattern reminded them of miniature waterfalls across the width of the faces of the strips.

To anyone planning to use lacewood for a project, I strongly recommend going to a vendor and personally choosing the boards. The boards vary widely in face grain pattern depending strongly on the orientation of the log when sawn, and not so much in their natural deep subdued reddish brown color. The faces of quartersawn boards have interesting grain patterns but the edges of such boards offer little to attract eyes. I bought my board long before this project was conceived simply because I thought it had interesting face grain patterns and believed it would make a nice accent with oak. (After bringing it home and comparing it against other wood finishes in my house, I think the natural reddish brown color fits very well color wise with the natural colors of many types of mahogany.) Note that the colors of this lacewood do not change dramatically when wetted with solvents or finish as do many other woods including the mahoganies in my home. When I first mentioned use of this wood as an accent for the tops of the Bookcases and TV Cabinet and showed her my "prize" board, my wife thought it would not go well. Now she and most others who have seen the completed project comment that they like the accent, which complements the light Pecan stain on the oak and picks up colors in the sofa and pillows located in the same room.

Be careful working with lacewood (and any other wood as well). Take care to avoid breathing the dust, and when handling the boards to prevent getting splinters. The board I bought from Rockler was S2S (surfaced on both wide sides but not the edges), and splinters were easily raised from its edges; I wore one in the palm of my left hand for a few weeks! Lacewood is hard, dense (noticeably more so than the red oak I used). I noticed tiny bright reflective spots on the surfaces of the lacewood when the boards were held up to a bright source of light from above and slowly rotated to change the angle of incidence; I suspect these bright dots may be deposits of silica or other minerals, something I definitely you do not want to breathe. I experienced no problems cutting lacewood with normal 48T carbide toothed saw blade supplied with my TS, but much care is needed to plane quartersawn surfaces without tearing out some of the grain on the surfaces prominently displaying the rays. A reduced planing angle of about 20 degrees is recommended. After laminating the boards to be cut into the valence components, I hand scraped and sanded the surfaces. Even so, I still created some slight tearouts which remain in the finished valence pieces.

I had only enough lacewood, to make all the needed valence laminated “boards” plus one extra side piece. After trying many different possible lamination arrangements with my oak stock, which were remnants of the strips I had cut for front edging of the Bookcases and TV Cabinets, I marked all the pieces to be assembled and glued them up into small boards slightly longer than needed for each piece of each valence. (I wanted to make the valences from a single board of oak so that I could match the grain patters all the way across at least the front boards, but did not have any single oak board in my stock that was sufficient in grain, color and length.) Because the strips of oak were 1 inch thick and the strips of lacewood only 3/4 inch thick, when gluing them together, I placed them into the clamps with their good faces down against the clamp bars, and checked to confirm their front faces were very close to flush so I would not have to do much scraping and sanding after lamination. I have found it possible using this rather slow, sequential panel glue-up technique to make even wide panels that will require very little planing or sanding, even if the boards being glued edge to edge are of widely differing thicknesses (because the “good” faces of the boards are always down and against the clamp bars). I have used this technique for many years when making table, desk, and and other furniture from glued up panels.

After making up the laminated boards for the valences, I mitred one end of each and fitted them together with masking tape, and dry fit them to the tops of the Bookcases and TV Cabinet to confirm I had the lengths correct. I used my TS 55 (set to cur a 45 degree bevel) and MFT to cut the mitres. I found that the bevel tilt stop on my saw was factory set at slightly less than 45 degrees. After a simple adjustment of the 45 degree stop set screw, the mitred pairs when joined formed 90 degree corners as desired. For the center pieces which appear across the fronts of the Bookcases and TV Cabinet, after getting the angles correct, I crept up on the correct length by repeat mitre cuts and taped up trial fittings to the tops of the Bookcases and TV Cabinet. Because my valence pieces were slightly longer than needed at the start of this iterative process, after I was certain of the angles, I then recut the mitres for the purpose of matching the rays in the lacewood as best as possible as the boards wrapped around each mitred corner. To accomplish this I recut both the front and side pieces as needed. After the final dry fit check, marked the back ends of the side pieces, then cut off the excess length from each. Then on my MFT tops I laid out the valence pieces for one cabinet at a time in a line with their mitred faces down, applied blue masking tape to surfaces facing up to join the boards into a long strip, flipped over the whole tape-joined strip, applied glue to the open mitre cuts, closed the mitred joints, and added more tape to pull the joints tight and laid them aside to setup. The strips of tape on the surfaces that will face outside in the finished valence act to draw the outside corners of the mitres together as the mitres are closed to form ninety degree corners. I checked the mitred corners after closure to ensure they were square. Another piece of wood corresponding to the length of the front member could be used to help ensure proper glueup, together with aluminum clamp up squares and spring clamps. Or you can use Collins mitre clamps, but their sharp points will leave slight impressions in the front faces of the valence boards. Or, if you're certain there is no glue squeeze out on the inside of the mitred joints, each valence could be fitted to its respective associated case and held against the top sub-frame members to assure proper alignment. I did not use this latter approach.

Installation of the Top Valences

The following photograph is of the top of the right Bookcase in the completed Entertainment Center. The topsides of the two Xenon lamps are visible in the holes sawn through the top crosspiece. The 12V transformer is the small white box screwed to the top cross piece of plywood that has a pair of pocket screws joining each end to the sides in addition to the three glued Domino tenons. The valence is secured from its inside surfaces by screws to the strips of 3/4 inch plywood secured to the top of the case by pocket screws. I extended the sides of the Bookcases and TV Cabinet 1/4 inch above the top cross panel of 3/4 inch plywood, thus making it easy to locate these top perimeter framing members to which the valences are secured. I did not secure the valences in place until the complete Entertainment Center was installed and leveled in the room where it resides. I intentionally set the valences in position with a slight gap to echo a similar feature in a china cabinet that can be seen when also viewing this Entertainment Center. When I installed the valences, I realized I could have used my Domino machine to cut some slots completely though the 3/4 inch top framing members facilitate vertical adjustment of the gap. And, assuming there would be a gap of about 1/4 inch between the tops of the cases and the valences, I could have pre-drilled some holes through the side members of these top perimeter frames and inserted small bolts or lengths of 1/4 inch threaded rods to invisibly secure the tops of the cases together without touching the valences themselves. But by this time I did not feel like taking the valences and these perimeter framing members off and back to the shop to drill through them. So the tops are simply clamped together at the back below the top.

Note that multiple pre-drilled connection holes through the side members of these top perimeter frames could be provided to enable connection of the Bookcases to the TV Cabinet at varying amounts of setback of the Bookcases relative to the TV Cabinet. The spacing of these holes in the top perimeter frames of the TV Cabinet and the Bookcases could be offset to create an effect similar to a vernier whereby a slight movement of the Bookcase toward its back relative to the TV Cabinet would cause a second hole through the perimeter frame of the TV Cabinet to line up with the first used hole of the Bookcase, and a further increment of movement in the same direction would cause a second hole in the perimeter frame of the Bookcase to line up with a the first used hole in the TV Cabinet, etc. I did not implement this design idea.

CHAPTER VII

Final Installation and Joinder of the TV Cabinet and the Console

You may recall that one of my design goals was to enable each of the four separately built pieces of this Entertainment Center to be used separately. That meant no visible holes through any of the finished outside front and side surfaces when assembling the four pieces into a single wall unit. I bought a pair of 4 inch tapered interlocking metal connectors (Item Number 00S53.05 from Lee Valley), expecting to use them to join the (upper) TV Cabinet and (lower) Console units together, to keep the TV Cabinet from being inadvertently pushed to the rear off the top of the Cabinet. But after receiving them, I realized they were not suitable for this purpose.

For use in joining together the Console and TV Cabinet, I made a pair of connector boards from scraps of ~7/8 inch thick oak. Each connector board was about 15 inches long by about 2 inches wide. In each board, I chamfered all four edges of one surface, and drilled and countersunk six evenly spaced holes, offsetting the holes to be about 1/2 inch from one of the lengthwise edges, using my Shopsmith in drill press mode. (The solid oak edging strips attached to the back edges of the side panels of the Console, Bookcases and TV Cabinet are all 1” x 1” in cross section, thus the offset of the screw holes in the connector boards was intended to locate the screws in the centers of the back edge strips.) After the TV Cabinet was set in place on top of the Console with their sides and rear edges aligned, I used the connector boards as a guide to drill pilot holes in the back edging strips, then affixed my shop-made connector boards with screws penetrating the 1 inch by 1 inch rear edging applied to the side panels of both the Console and TV Cabinet. I slightly offset the connector boards inward relative to the sides of the Console and TV Cabinet so they would not interfere with positing of the Bookcases. With this design, it is possible to set the Bookcase units further back (closer to the wall) than are the Console and TV Cabinet. This may be desired to help hide the maze of electrical wires and cables.

If it is desired to only align the Bookcases, Console and TV Cabinet so that their fronts and backs are always forming a straight line (as shown in my photographs), the connector boards could be made wider, and thereby serve also as backstops when the Bookcases are slid into position at final arrangement in a room. I don't recommend joining the lower backs of all four

pieces of this Entertainment Center to one another because their combined size and weight which would make it very difficult to move as a singe unit.

List of sources of materials and hardware used.

1. Kiln-dried, red oak lumber in 4/4 (rough planed (the Amish call it "hit or skip" planed)), 5/4 fully planed and 4/4 poplar rough planed, from Keim Lumber, Charm, OH. Keim will deliver at no extra charge within 150 miles of their location.
2. Plain-sliced red oak plywood in 3/4 inch and 1/4 inch thicknesses, from Keim Lumber, Charm, OH. This is USA or Canadian plywood with poplar veneer core. The actual width and length of the sheets are about 48 1/2 inches and 96 1/2 inches. The edges were close to being true and the corners close to square, but not as smooth as is normal when cut with a Festool TS (track saw), certainly not good enough for glue up of edging. I found I could get four 12 inch wide by full length strips from a sheet using my TS 55, 3000mm Guide Rail and 48 T Fine Cut Blade. I used approximately 4 1/2 sheets of 3/4 inch plywood and 3 sheets of 1/4 inch plywood, plus a few small pieces of 1/2 inch birch plywood (for the drawer bottoms) in making this Entertainment Center.
3. Ball Tip Solid brass, no-mortice hinges for the doors, Item Number 143-600 (antique bronze finish), Woodworker's Supply, Casper, WY (formerly Albuquerque, NM).
4. Pebbled glass inserts for the doors of the Console were purchased cut to size from a local glass dealer. This and many other types of glass can be purchased from a supplier of architectural materials. Outwater Plastics Industries, Inc. and Architectural Products lists >50 varieties of decorative glass. Note they have minimum order requirements!
5. Tresco brand, PocKit Xenon (20W bulbs) Light Kits, from Eagle America, Chardon, OH. A 2-Lamp Kit, Item Number 475-0514 (gold trim ring), was used in each Bookcase, and a 3-Lamp Kit Item Number 475-524 (gold trim ring) was used. Eagle America did not stock the compatible Tresco solid state Dimmer Unit.
6. Hole Saw, 2 1/8 inch diameter, from Lee Valley. This item is likely to be available from Home Depot or Lowe's or other hardware or tool supply stores. Note that a mandrel is needed for this and other hole saws, and a drill with a 1/2 inch Jacobs style chuck.
7. Tresco brand Switch Kit (black), Item Number 475-0502, Eagle America or Rockler under different stock number.
8. Tresco Dimmer Unit (only one is needed to operate up to three sets of Xenon PocKit Light kits), Item Number 39912, from Rockler Woodworking and Hardware.
9. Shelf pins, 1/4 inch spade type, antique brass, Rockler Item Number 22765. (A total of 56 pins were needed.)
10. Four Drawer slides, 100 lb rated, full extension, Black, Item Number 02K36.16, from Lee Valley. (Screws are included, but may be too long depending on thickness of door sides.)
11. Two Door Pulls, Mulholland Square Suite, AB (Antique Brass), Knob, Item Number 02A45.30 (corresponds to Amerock BP50329-R3), from Lee Valley.
12. Magnetic Door Catches (Brown), Rockler.
13. Adjustable Leveler Glides, Item Number 01S08.01, from Lee Valley and the same product as Item Number 81239 from Rockler were installed in the bases of the Bookcases and Console.
14. Screws for installation of the back panels, Lee Valley Item Number 01Z53.05, 2 packages of 100 screws each. Approximately 160 were needed.

15. Two round Grommets, 1 1/2 inch diameter, brown, Lee Valley Item Number 00U08.22. These are not absolutely necessary if you're willing to move the Bookcases away from the wall and loosen some of the screws holding on the back in order to fit speaker / lamp wires through.
16. Twelve pieces 5mm tempered glass, 10 inch x 10 inch square (nominal), Stock Number K14201, from ABC Target, Brooklyn, NY. (They had no minimum order requirements when I purchased.)
17. Plastic supports for 1/4 inch thick and 1/8 inch thick adjustable drawer divider panels were purchased from Outwater Plastics Industries, Inc.
18. Molded plastic inserts for storage of DVDs and CDs, from Lee Valley and Rockler. Good fitment to CD "jewel cases." None of them correctly fit DVD packaging used in USA which is thicker than jewel cases.
19. Nylon Cable ties purchased locally.
20. Saddle Mounts (for nylon cable ties), Small size, Item Number 03K76.01, and Medium size, Item Number 03K76.02, Lee Valley.
21. Finishing Materials: Oil Stain (wiping type), General Finishes brand, Pecan color, from Rockler and Woodcraft
Zinnser's SealCoat dewaxed shellac
Oxford brand (Target Coatings) water based Amber Shellac, Sanding Sealer, Gloss and Semi-Gloss Laquers, Homestead Finishes.
Wet or Dry Silicon Carbide abrasive papers, 320 grit and 400 grit in addition to various Festool abrasives for ETS 125 and LS 130.

CHAPTER VIII

GENERAL NOTES, COMMENTS AND RECOMMENDATIONS

1. Obtain all hardware, glass panels, lighting, drawer slides and other purchased components before finalizing the design and beginning construction. Doing so will save rework due to later obtained components that do not fit your design and construction.
2. Build a rigid "torsion box" style base for each case unit and use these torsion boxes to assure the bottom panel will be a flat, reliable reference from which to set other critical dimensions, e.g. the elevations specified for any horizontal cross members, shelves and shelf pin holes. I did not, and that made some of the subsequent measuring and marking steps more difficult and less trustworthy. I would have saved time and less dry fit checks would have been required had I followed this recommendation.
3. When ripping narrow strips of natural wood boards, expect some of them to warp or wind. Rip a few extra pieces while you have this setup so you don't have to take apart some other work setup to set up for ripping narrow strips again.
4. Pre-finish components if you can, at least through the step of applying the stain. Apply masking tape over surfaces and mortices to be glued later. This is especially helpful where small cubby holes will exist in the assembled because it will be difficult to apply finish coats to the inside surfaces of these compartments, e.g in the upper compartments of the TV Cabinet and to a lesser extent inside the Bookcases. To get a uniform overall finish and appearance, consider leaving application of the final finish coats until after complete assembly. If applied earlier, the final finish coats might not be uniform for a variety of reasons, of might become

damaged during subsequent assembly steps. Don't install the backs until the finish has been applied to the insides of the cases.
5. Make a batch of looser fitting (5mm) Domino tenons for use in dry fitment checks by sanding away a little from their sides and edges, and chamfering their ends until they can be inserted and removed with little force. This will save a lot of time when making dry fit assembly checks because you will be able to insert and remove those looser tenons easily. The 5mm tenons originally supplied with my Domino machine me could not be pushed in by hand, and even after light sanding of all their surfaces often required Vice Grip pliers to remove. Some even broke while trying to remove them with a pair of Vice Grips when nothing else would budge them. I keep these looser-fitting tenons in a separate bag within the same Systainer in which my Domino Assortment (Item #493301) came. I needed nearly 100 of them for dry fitment checks of the Console and TV Cabinet.
6. The cost of materials, especially plywood, could be slightly reduced if the bookcases were resized / redesigned to enable use of the full width of the pieces cut from a sheet. The Bookcases I built are 28 1/2 inches wide which means I needed a full sheet of 1/4 inch plywood for the back. Alternatively, four bookcases, each using 1/2 sheet of plywood for its back (24 inches wide) could be built to maximize use of the materials that I purchased. but more solid wood and more 3/4 inch plywood would be needed. The design I built did make fairly efficient use of the ¾ inch thick plywood sheets.

Possible Design Changes for the Entertainment Center

Although I and my family are quite satisfied with the Entertainment Center described above that I built, I would consider the following changes if I built another.

1. Increasing the width (vertical dimension in the finished cases) of the top edging strips (the horizontal strips just below the valences) of the Bookcases and TV Cabinet. The primary reason I would do so is to decrease the sight lines to the lamps in the top cross panels. Increasing the vertical dimension of these top crosswise edging members would enable insertion of two Domino tenons joining each end to the edging of its associated Bookcase and TV Cabinet, which would significantly increase their resistance to racking deflection upon side loading, especially when the back panel is not inserted into the recesses in the back sides of the Bookcases and TV Cabinet. Note there have been no problems upon lifting and moving the designs of the Bookcases, Console and TV Cabinet that I built; but as an engineer, I tend to over design items.

2. Increasing the width of all edging used on the vertical panels, especially the sides of the Bookcases and TV Cabinet. This would increase the bending stiffness of the edged panels and help keep them straight. (Resistance to bending deflection of a simple beam is proportional to the cube of its depth; i.e., a 2 inch wide (deep) board has 8 times the resistance to bending as a 1” wide board if all other dimensions and properties are equal.) If you look very closely at the contiguous vertical edges where the Bookcases abut the TV Cabinet, you may be able to see a very slight gap along portions of those ~5 ft long edges. Unlike a kitchen cabinet installation, I do not want to drill any holes through these side panels for installation of screws or other panel connecting bolts, but would like these slight gaps to not exist.

3. Locating the lamps closer to the front edges of the Bookcases and TV Cabinet. This would decrease the sight lines to the lamps in the top cross panels. This is simply a matter of preference. If your eyes are able to see the lamp themselves while sitting to watch TV, the

bright sources of light can be distracting to your eyes. I would have chosen to totally hide the lamps behind the front horizontal edging strips, but did not find a source of possibly suitable lamps until I had finalized the design I built including the PocKit lamps. Outwater Plastics Industries, Inc. and Architectural Products lists many lighting products in their large catalog, some of which might enable achievement of the hidden lamp effect I would have preferred without using much wider (greater vertical dimension when installed) boards for the top edging which would have not fit the aesthetic goals of the design. Others considering a similar project can look forward for the lighting industry to continue to introduce more LED products, including lamps that can be dimmed. I could not locate any such products when I had to make my lighting choices, and did not know of sources like Outwater too late for my project.

4. Increasing the front to back dimension of the sides of the Console relative to the front to back dimension of the shelves to provide greater overhang of the sides to facilitate hiding the wires and cables from view from either side of the unit. With an increase in these overhangs, the entire unit could be positioned closer to a wall without having to force the cables to be bent to as small a radius as would happen if the currently built design was positioned with its side edges nearly touching the wall. Due to use of very stiff "Monster" brand coaxial cables on my electronic equipment, my Entertainment Center is positioned about 2 1/2 inches out from the wall. My wife would prefer those cables not able to be seen at all from any angle.

5. Offsetting the drawers more toward the center of the Console. In the Console as built, the doors must be fully opened (180 degrees) to enable the drawers to be opened without hitting the door frames. This slight design change would allow the drawers to be pulled out without any interference with the doors opened at least 90 degrees. Of course, this design change would necessitate revision of the dimensions of several other components of the Bookcases and TV Cabinet if the "Stack of Cubes" visual effect was to be retained.

6. Possibly replacing the fixed upper shelves behind the doors of the Console with a third drawer, for increased storage capability of CDs and DVDs. The overall height of the Console might have to be increased beyond its present 24 inches to accommodate this change.

CHAPTER IX

Cutting Lists

Following are cutting lists based on my handwritten lists used in making the Entertainment Center. I would have liked to include copies of my labeled drawings as well, but have not been able to scan them. The graphite pencil lines are apparently to light for the scanner to capture them.

CUT LIST
for
CONSOLE of Entertainment Center

by

Dave Ronyak

Letter ID	Description	Quantity	Dimensions Th x W x L (inches)	Material Type	Notes	
A	L/R Edging of Top	2	1 x 2 x 19	Red oak	Allow extra L for mitres, extended width mortices to enable assembly	
B	Front Edging of Top	1	1 x 2 x 52	Red oak	Allow extra L for mitres	
C	Center Panel of Top	1	¾ x 17 x 48	Red oak plywood	Drill pocket holes on top surface to aid clamping	
D	Front Edging on Side Frame Panels J	2	1 x 1 ¼ x 23	Red oak	Join to J with tenons, center on edge of J	
E	Front & Rear Top Frame Stretchers	2	¾ x 3 x 50	Red oak	Front edge is exposed. Pocket Screw Holes Rear needs 1/4" shim	
F	Front Edging on Bottom Panel	1	1 x 1 x 49 1/2	Red oak	Join to D with tenons, flush with top surface	
G	Vertical Partition Panels	2	¾ x 17 x 19¼ plus ¼"	Red oak plywood	"plus ¼" for reduced thickness of top panel C or add ¼ shims when installing top	
H	Front Edging on G	2	¾ x 1 x 191/4	Red oak	Optional Domino tenons to G	
I	RESERVED					
J	L/R Side Panels	2	¾ x 17 x 23	Red oak plywood	Apply D and K with tenons	
K	Rear Edging on Side Frame Panels J	2	1 x 1 x 23	Red oak	Join to J with tenons	
L	Front Toe-Kick	1	¾ x 3 x 49 1/2	Red oak	Cut slightly long, adjust to fit during dry fit after applying edging to J, Recess ¼" from front, attach with pocket hole screws	
M	L/R Fixed Shelves	2	¾ x 17 x 12¾	Red oak plywood	Inset 1 1/8' from front Cutout back edge for cables as needed	
N	Front Edging on M	2	¾ x 1 x 12 ¾	Red oak	Trim glued up M + N to 17 7/8 minus thickness	

					of back panel if any	
Letter ID	**Description**	**Quantity**	**Dimensions Th x W x L (inches)**	**Material Type**	**Notes**	
O	Top Outside Filler Strip	2	¼ x 2+ x 17	Red oak	Use is optional, for appearance only, match width to door rails	
P	Bottom Outside Filler Strip	2	¼ x 3 x 17	Red oak	Use is optional, for appearance only, match width to Toe-Kick	
Q	Door Stiles	4	1 x 2 x 19	Red oak	Adjust overall door height after construction for clearance between Top B and Bottom F edges of panels	
R	Door Rails	4	1 x 2 x 9 ¼ *	Red oak	*Length can vary depending on amount of overhang desired of partitions G	
S	Pebbled Glass Panels	2	As required	Glass	Size to fit door frames	
T	Adjustable Shelves (fit into center opening of Console, can be reversed to present different front edge appearance)	2	¾ x 16 x 23	Red oak plywood	Adjust length to fit shelf pins, adjust panel width according to edging width for overall Console depth and front setback desired	
U	Edging on front of T	2	¾ x 1 x 23	Red oak	See notes for T	
U'	Edging on rear of T	2	1 x 1 x 23	Red oak	See notes for T	
V	Bottom Panel	1	¾ x 17 x 50	Red oak plywood	Optional pocket holes on bottom surface to aid drawing M&T joints closed during clamping	
W	Front Edging on V	1	1 x 1 49 1/2	Red oak	Join to V with tenons, adjust length at dry fit, flush with upper surface of V	
X	Sub-frame pieces under V	5	¾ x 3 x ??	Oak or other hardwood	Join to V, J and one another with pocket screws, make recessed area in center of back for power outlets strip	
Y	Filler Strip on panels J	2	1/4* x 2* x 17	Solid or plywood, stain to match interior	For clearance of drawer slides. Increase thickness for greater clearance of drawer slides to door hinges	
Letter ID	**Description**	**Quantity**	**Dimensions Th x W x L (inches)**	**Material Type**	**Notes**	

Letter ID	Description	Quantity	Dimensions Th x W x L (inches)	Material Type	Notes	
AA	Drawer Sides	8	½ to 5/8 th x 6 x 16 ¼ L	Builder's choice. Poplar used in original.	Thickness choice interrelated to other drawer dimensions, type of joints used, and slides choice	
BB	Drawer Fronts and Rears	8	½ to 5/8 th x 6 x 16 ¼ L	Builder's choice. Poplar used in original.	Thickness choice interrelated to other drawer dimensions, type of joints used, and slides choice. Fronts stained.	
CC	Drawer Bottom	4	¼ to ½ th x W x L	Original used ½ birch plywood	Thickness choice and drawer construction will affect effective drawer interior depth. Bottom panels of original Console set flush with bottoms of sides by rabbeting edges of panels and dados in drawer sides, fronts and rears. Interior surfaces of sides, fronts and backs dadoed for panel divider supports.	

CUT LIST
for
TV CABINET of Entertainment Center

by
Dave Ronyak

Letter ID	Description	Quantity	Dimensions L x W x H (inches)	Material Type	Notes	
A	L/R Front Edging on B	2	1 x 1 ¼ x 54	Red oak	Center on thickness of B, attach with tenons	
B	L/R Side Panels	2	¾ x 12 x 54	Oak plywood	Put best face outside if cabinet may be used without Bookcase	
C	L/R Rear Edging on B	2	1 x 1 x 54	Red oak	Offset to outside of B, attach with tenons	
D	Lower Cross Panel	1	¾ x 12 x 50	Oak plywood	Attach to Side Panels B with tenons **after** joinder to Vertical Dividers and Top Cross Panel	
E	Front Edging on D	1	1 x 1 x 49 ½ *	Red oak	Cut long, adjust length at dry fit, mortices in ends, attach with tenons flush to top surface of D	
F	Top Cross Panel	1	¾ x 12 x 50	Oak plywood	Attach to Side Panels B with tenons **after** joinder to Vertical Dividers and Bottom Cross Panel	
G	Front Edging on F	1	1 x 1 ¼ x 49 ½ *	Red oak	Cut long, adjust length at dry fit, mortices in ends, attach with tenons centered on edge of F	
H	Vertical Dividers	2	¾ x 12 x 13 1/8*	Oak plywood	Attach to Top and Bottom Cross Panels with tenons, attach 1 ¼ front edging with tenons	
I	Front Edging on Divider H	2	1 x 1 ¼ x 13 1/8	Red oak	Adjust length at dry fit, mortice ends, attach with tenons, center on edge of H	
J	Reserved					
K	Back X-Member connecting C at bottom (Stretcher)	1	7/8 to 1 x 4 x 50	Red oak	Cutout region at midspan for cables, radius edges, tenons to sides and Back Center	

					Vertical Brace	
Letter ID	**Description**	**Quantity**	**Dimensions Th x W x L (inches)**	**Material Type**	**Notes**	
L	Back Center Vertical Brace	1	¾ x 4 x ~36 ½ *	Red oak	Tenon joints to both top edge of K and bottom of D, exact length dependent on actual width of K	
M	Lower Back Panels	2	¼ x 23 5/8 W* x 36 7/16 H*	Oak plywood	Approx. Dimensions. Fit at assembly, recessed into back of frame members	
N	L/R Upper Back Panels	2	¼ x 13 ½ W x 13 ½ H*	Oak plywood	Approx. Dimensions. Fit at assembly, recessed into back of frame members	
O	Center Upper Back Panel	1	¼ x 23 5/8 W x 13 ½ H	Oak plywood	Approx. Dimensions. Fit at assembly, recessed into back of frame members	

CUT LIST
for
BOOKCASE of Entertainment Center

by

Dave Ronyak

Letter ID	Description	Quantity	Dimensions Th x W x L (inches)	Material Type	Notes	
A	Valence Front	1	1 x 4 x 28 1/2	Red oak & Lacewood	Laminated woods, allow extra length for mitres	
A'	Valence Sides	2	1 x 4 x 14	Red oak & Lacewood	Laminated woods, allow extra length for mitres	
B	Bottom Front Toe-Kick	1	¾ x 3 x 26	Red oak	Recess ¼" from front, attach with pocket hole screws	
C	Front Edging on Side Panel F	2	1 x 1 ¼ x 78	Red oak	Center 1¼ dimension on edge of F, tenons	
D	Front Edging on Top Cross Panel	1	1 x 1 ¼ x 26*	Red oak	Cut long and trim at dry fit, tenons to C and top cross panel, center on edge of J top panel	
E	Fixed Shelf Partitions	2	¾ x 11 3/4* x 12 7/8*	Oak plywood	Add 1" Th oak front edging, adjust dimensions at dry fit	
F	L/R Side Panels	2	¾ x 12 x 78	Oak plywood	Alignment of shelf pin holes with those in H and bottom cross panel of TV Cabinet	
G	Back Panel	1	¼ x 27 ¼* x 75*	Oak plywood	Adjust dimensions at dry fit, length can be longer if desired	
H	Center Divider Panel	1	¾ x 12 ¾ x 73	Oak plywood	Alignment of shelf pin holes with those in F	
I	Front Edging on H	1	1 x 1 ¼ x 73	Red oak	Cut long and trim at dry fit, tenons to edging on bottom and and top cross panels	
J	Top Cross Panel	1	¾ x 12 x 26 ½	Oak plywood	Fit 11/4" front edging at dry fit	
J'	Bottom Cross Panel	1	¾ x 12 x 26 ½	Oak plywood	Fit 1" front edging at dry fit	
K	Front Edging on J' (bottom panel)	1	1 x 1 x 26	Red oak	Trim length at dry fit, mortice ends and to J'	
L	Adjustable Shelf	6	¾ x 11 3/4* x 12 ¾ *	Oak plywood	Add 1" Th oak front edging, adjust	

					dimensions at dry fit and to shelf pins, optionally rout for glass insert	
Letter ID	**Description**	**Quantity**	**Dimensions Th x W x L (inches)**	**Material Type**	**Notes**	
M	Valence sub-frame Front	1	¾ x 3 x 26 ½	Plywood	Pocket screw holes	
N	Valence sub-frame Side	2	¾ x 3 x 12 ¼	Plywood	Pocket screw holes	
O						
P	Subframe pieces under J	3	¾ x 3 x ??	Oak or other hardwood	Back X-piece joined to Side Panels, and two short pieces joined to back X-piece and to Toe-Kick with pocket screws	

I hope my story above has been informative to least some members of FOG who may be interested in how I used my Festool products, and how I addressed design and construction issues working alone in my small shop. I tried to add enough detail to aid those who are not professional woodworkers or otherwise well experienced. I am deeply ingratiated to several members who offered and provided assistance in posting photographs, and for creating a consolidated draft PDF document of the entire project based on my many posts in this thread. Best wishes to anyone who decides to build an entertainment center.

Dave Ronyak
December 25, 2008