Chapter

2

Building and Finishing a Multiple Unit Built In Bookshelf

In this chapter, you will learn the following to World Class standards:

- **Researching Shelves**
- **Designing a Built In Bookshelf**
- **Materials Needed to Finish a Bookshelf**
- **Fabricating a Bookshelf in the Factory**
- **Pre-finishing a Bookshelf in the Factory**
- **Assembling the Bookshelf Onsite**
- **Inspecting the Assembly**

Researching Shelves

In this project, we will discuss how to build and finish a simple bookshelf that is made out of wood. The bookshelf can be a single or a multiple unit. The assembly can be freestanding or built into the wall. In this chapter, we will concentrate on the procedures to finish the assembly. No matter how we construct the wooden bookshelf, the techniques to paint the assembly remains the same and the only difference will be in the amount of materials we need to complete the job.

Before we start this lesson, we must learn about shelves in general. What type of shelf do we find, a bookshelf, a pantry shelf or another type? How tall are typical wooden shelves? How wide? What is the depth? How many shelves are in the unit? What is the distance between the shelves? What is the thickness of the board holding the books? What is that size of the boards on the sides? What method of fastening do we use to connect the boards? What type of finish does shelving have? What color? Finally, what was the date the shelving unit was built?

	Unit One	**Unit Two**	**Unit Three**	**Unit Four**
Type of shelving unit	*Book*			
Built in or standalone	*Built in*			
Construction material	*1.0 in. pine*			
Height of bookshelf	*120 in.*			
Width of bookshelf	*37.5 in.*			
Depth of bookshelf	*9.25 in.*			
Number of shelves	*9*			
Distance between shelves	*12 in. min.*			
Thickness of shelf	*0.75 in.*			
Thickness of sides	*0.75 in.*			
Fastening method	*0.75 in.*			
Type of finish	*High Gloss Enamel*			
Color	*White*			
Date built	*2007*			

Figure 2.1 – Researching Bookshelves

We went to visit a small library to research their built in bookshelves. Then we placed the data into the table shown in Figure 2.1. Your assignment is to research three more shelving units and place their data into the table. Share your information you have found with the other individuals conducting this exercise in with your instructor. Look for similarities and differences and write down any questions that you have regarding the construction of shelving units. Ask the instructor those questions when that subject is covered during this chapter,.

Designing a Built In Bookshelf

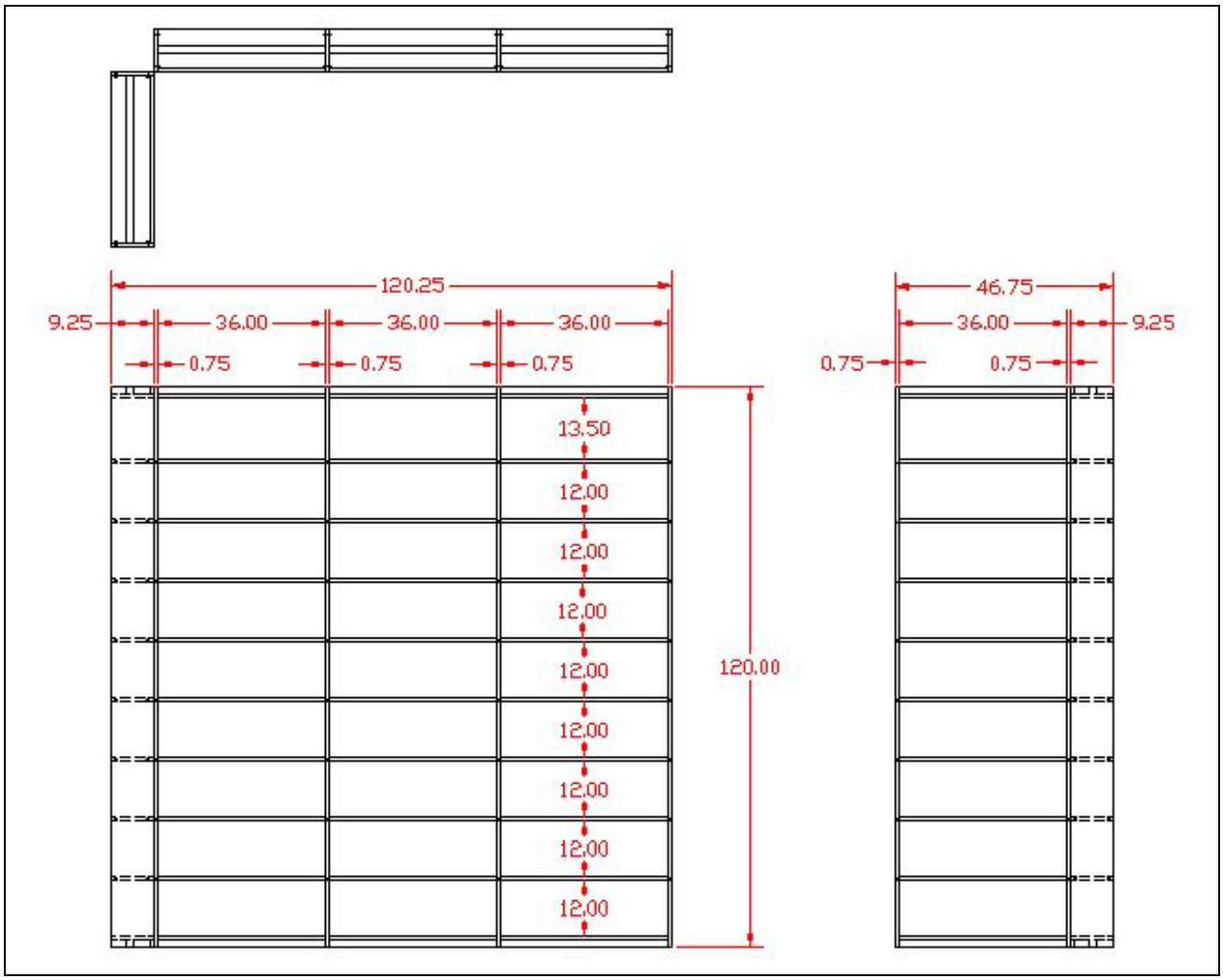

Figure 2.2 – Sketch of the Bookshelf Assembly

We are going to use the information from unit one in our research to create production drawings and finish notes to construct a built in bookshelf. Our bookshelf has four units, three in a row and one at 90° that is built in to the wall. In figure 2.2, we see the dimensions on the engineering sketch to help us make a bill of material.

A few questions can arise from the design of the library shelves. How are the sideboards attached to the wall? Are the shelves attached permanently or are they removable? How can we

hold the weight of the books and the shelves safely?

We will attach two 2×4 studs to the ceiling and to the floor to hold the sideboards into place. We will have removable shelves to allow us to paint the boards and set them into place with minimal damage to the pinewood. If some of the shelving units have different size shelving boards, we will place a small number on the side of the board that matches the position in the assembly, so that if the number of boards are removed at any time, we can return the board to the correct position.

Now we will make a bill of material for the assembly from the sketches in figures 2.3 and 2.4.

Item No	Part Number	Description	Size	Qty
1	2008021	Stud	2×4×36	16
2	2008022	Shelf	1×10×36	40
3	2008023	Sideboard	1×10×120	6
4	2008024	Cover Plate	1×1.5×36	8
5	2008025	Shelf Clips	Purchased	128

Figure 2.3 – Bookshelf Bill of Material

This kit is prepared in the factory for the installation at the site. All but the four studs have a coat of primer and a single coat of high gloss enamel. First, the studs are attached to the floor and ceiling joists with deck screws. Then the sideboards are attached on each end of the shelves. At the factory, there are 16 holes drilled in each sideboard for the shelf clips and 12 pilot holes for the wood screws that attach the sideboards to the studs. A shelf and cover plate box in the studs on the top and the bottom of the assembly. After we box in the top and bottom areas, the shelving clips are placed in their mounting holes and the shelf boards are laid into position. The technicians then prepare the surfaces for a final finish and add one last coat of high gloss enamel. Last of all, the unit is inspected for quality.

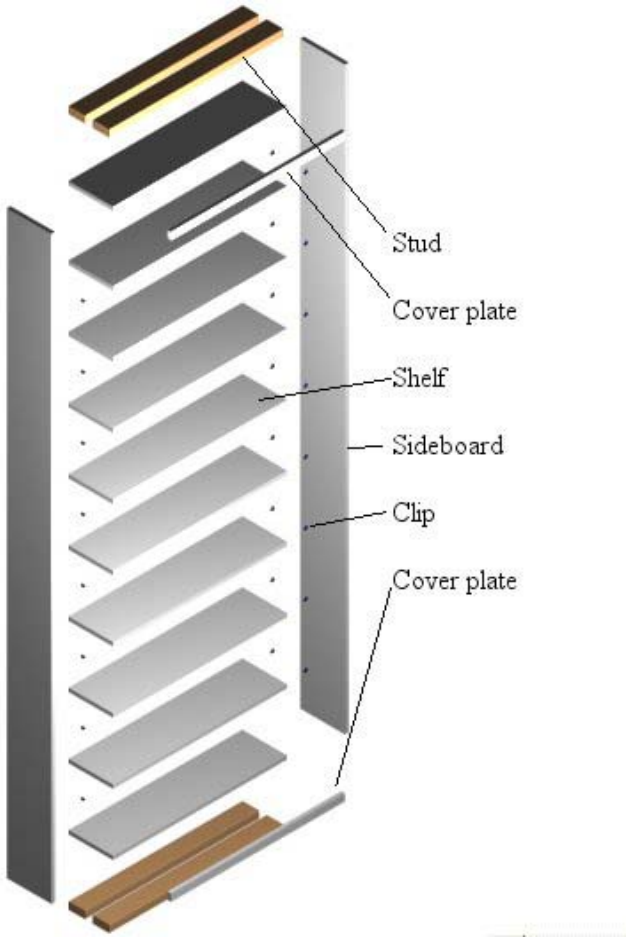

Figure 2.4 – Exploded View

Materials Needed to Finish a Bookshelf

Unlike previous building projects, this on site assembly will require the technicians to bring some factory workshop materials with them for field work and repair.

The following is a list of materials we will need to finish the bookshelf.

One gallon of interior wood primer (latex)
One gallon of interior latex enamel
One tube of interior latex caulk
A small amount of joint compound or wood filler – easy sanding
A drop cloth
A few paint rags

The following is a list of tools needed for the project.

Latex paint brush
Role sleeve and arm
Putty knife
Caulking gun
Standing sponge of paper (100 grit)
Paint pan
Hammer and nail punch
Stir stick
Dust brush
Extra lighting

Fabricating a Bookshelf in the Factory

All of the wooden components need to be fabricated before receiving the primer and first finish coat. The boards for the shelves are cut to length, which are 36 inch long for this project. Two of the boards, the top and the bottom have 6 – 3/32 diameter holes drilled through the board with a 3/16 diameter countersink. The other boards do not have holes drilled into them.

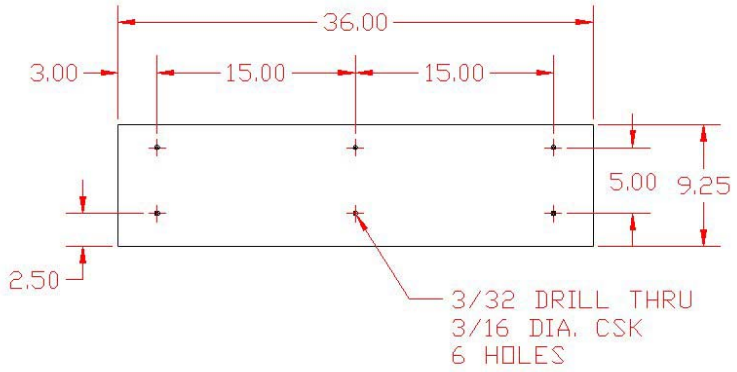

Figure 2.5 – Machining the Shelf Board

We cut the sideboards to length based upon the measurements made during a visit to the site. End sideboards such as the one shown in figure 2.6 will have 16 holes drilled 3/8 deep into the

¾ thick board for the mounting clips. On the opposite side, 0.09 diameter holes are drill through the board with a 3/16 diameter countersink to hide the head of the wood screw.

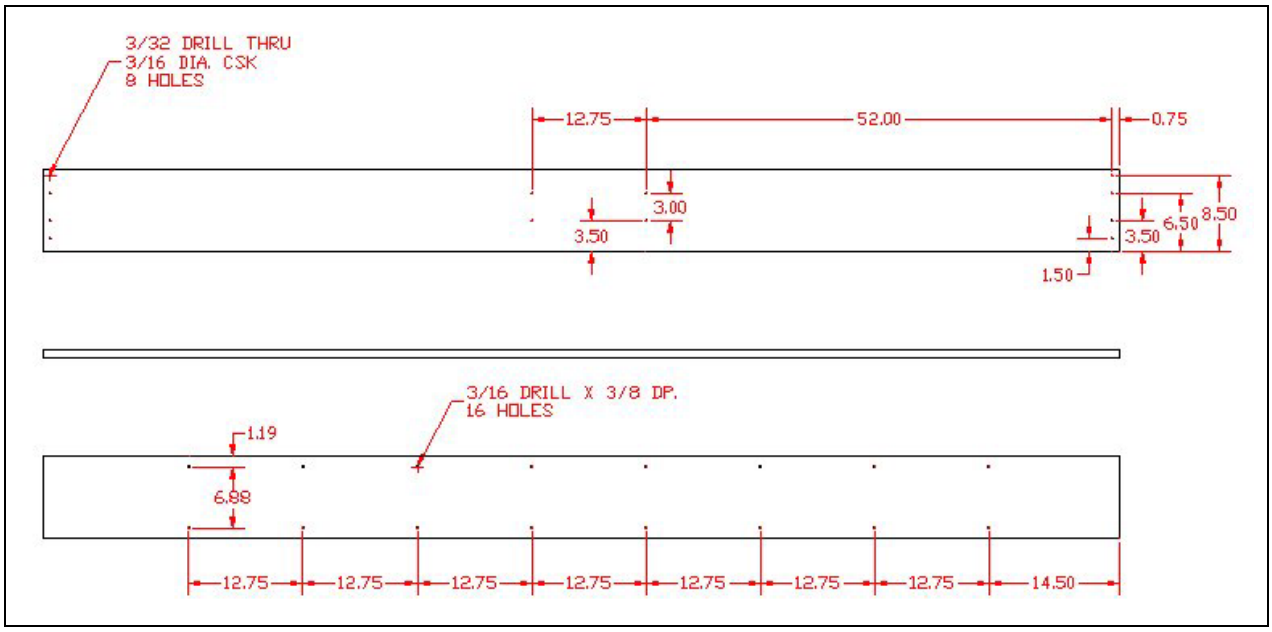

Figure 2.6 – Fabricating the Sideboard

After all the boards are machined, we will prime and add a single coat of high gloss enamel to reduce the amount of work on site.

Pre-finishing a Bookshelf in the Factory

To have a good finish on the bookshelf, at this point of project, the work area needs to be clean and dust free. Initially, we need to clean up any debris, dirt or dust that was created during the process of building the shelves and sideboards. Periodically, we need to clean the work area again such as after sanding the primed boards. Having small pieces of dust and dirt in the enamel paint can cause the surface to appear bumpy and irregular. Whenever possible we paint the sideboards and shelves with a coat of primer and a single coat of enamel prior to assembly.

When the boards are cut to length and the holes for the mounting clips are drilled, sand any rough edges smooth and clean the drilled holes out. Have a couple of sawhorses or stands to set the boards up off the ground. Open and stir the primer. If the can has been setting around for a long period, we can bring the can of primer to a hardware store and have the primer shaken to mix all the solution in the can.

Pour the primer into the paint pan, because we never want to work out of the full can of primer. First, working out of the full can makes for easy spills, because the can has a higher center of gravity than the lower and wider paint pan. Next, the painter has a harder time getting access paint off the brush and there is less dripping. Moreover, the paint pan allows for easier carrying and handling. After pouring the primer into the pan, use the paintbrush to clean off the side of the can.

Slide the roller cover on the roller arm, and check that the roller assembly spins easily.

Start priming the wood shelf or sideboard at the top and work down the board. When a couple of feet is covered, move down to the next section. Roll down to cover unpainted wood and when returning the roller back towards the top, pick the roller up from the board when we achieve full arm extension, so no drips or excess paint remain on the board. As we move to sections of the boards, where there are natural knots in the wood, using the roller press primer into the area. We usually press primer into these areas and then roll the section. After completing the edges of the board and a single side, place the board against a wall in an area with lint free paper to allow the primer to dry. Repeat the process on the other shelves and sideboards.

After an hour, we can handle the boards to prime the last side. Use a soft paint rag or towel to place between the sawhorse or stand and the primed board, so the board is not scratched. Repeat the priming process on every board in the bookshelf assembly, returning each board to the drying area. Pour the remaining primer back into the primer can and seal the can, so we can use the solution later. Clean the paint pan, roller and brush.

After one hour, the boards will be dry. The primer raises the pine wood surface and if we move our hand across the surface of the board, we will feel the bumpy and uneven texture of the primed wood. Use the 100 grit sanding sponge or paper to smooth the wooden shelves and sideboards. If we have two workers, a painter and an assistant, the assistant can take the first board that was primed 60 minutes ago, and start to sand the board to an even smoothness. When the board is sanded, we dust off the board with a clean brush, and the unit can be set on the padded painting stand, so the painter can start to apply the first coat of high gloss enamel. The painter will do the edges of the board and one side and then move the board to the drying area. The assistant will continue to feed sanded primed boards to the painter until every board is completed. After the first board is dry, we paint the last side with the latex enamel. If we do this work at the jobsite, then we place the dry boards into the bookshelf, assembling and fastened them together. If this initial priming and painting is done at the factory workshop, then the boards will be placed on a pallet or a container to protect the surface when in shipment. We find that we work more efficiently doing as much work in our factory and then assembling and doing the last coat on site.

Assembling the Bookshelf Onsite

Now that we have the pre-manufactured parts for the shelving at the site, we mark the location for each sideboard. At the top and bottom of the bookshelf, we will screw in two 2 × 4 × 36 long studs. We attach one stud against the back of the wall and one we secure 8.5 inches from the rear of the wall. We do this on the top and the bottom. Sometimes the walls are not at perfect perpendicular with the floor or the ceiling and we have to adjust the studs to allow the bookshelves to stand perpendicular to the floor. After nailing the studs to the floor and the ceiling, we use wood screws and assemble the sideboards to the studs.

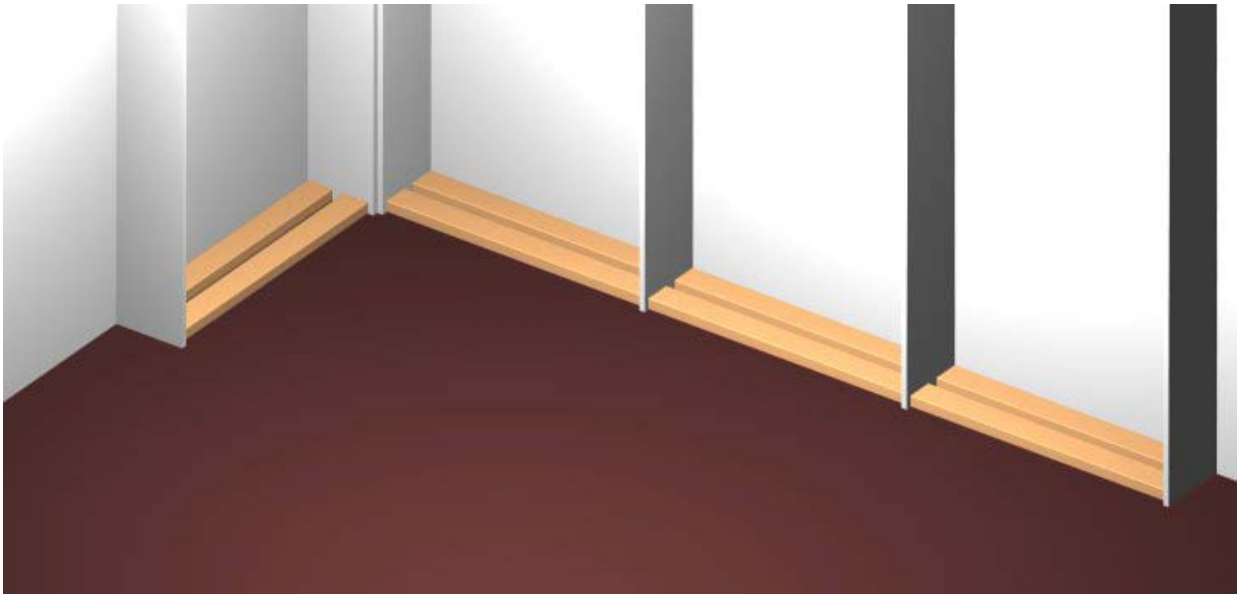

Figure 2.7 – Assembling Studs and Sideboards

When putting the built in bookshelf into a corner, we can nail the sideboards to the studs, push the assembly into position and then screw the studs to the floor and ceiling joists. Since floor and ceiling joists are typically on 16-inch centers, we can get two sets of screws from each stud into each joist, because the bookshelf unit is 36 inches wide. Use a stud finder to locate the joists and lightly mark the wall for easy reference.

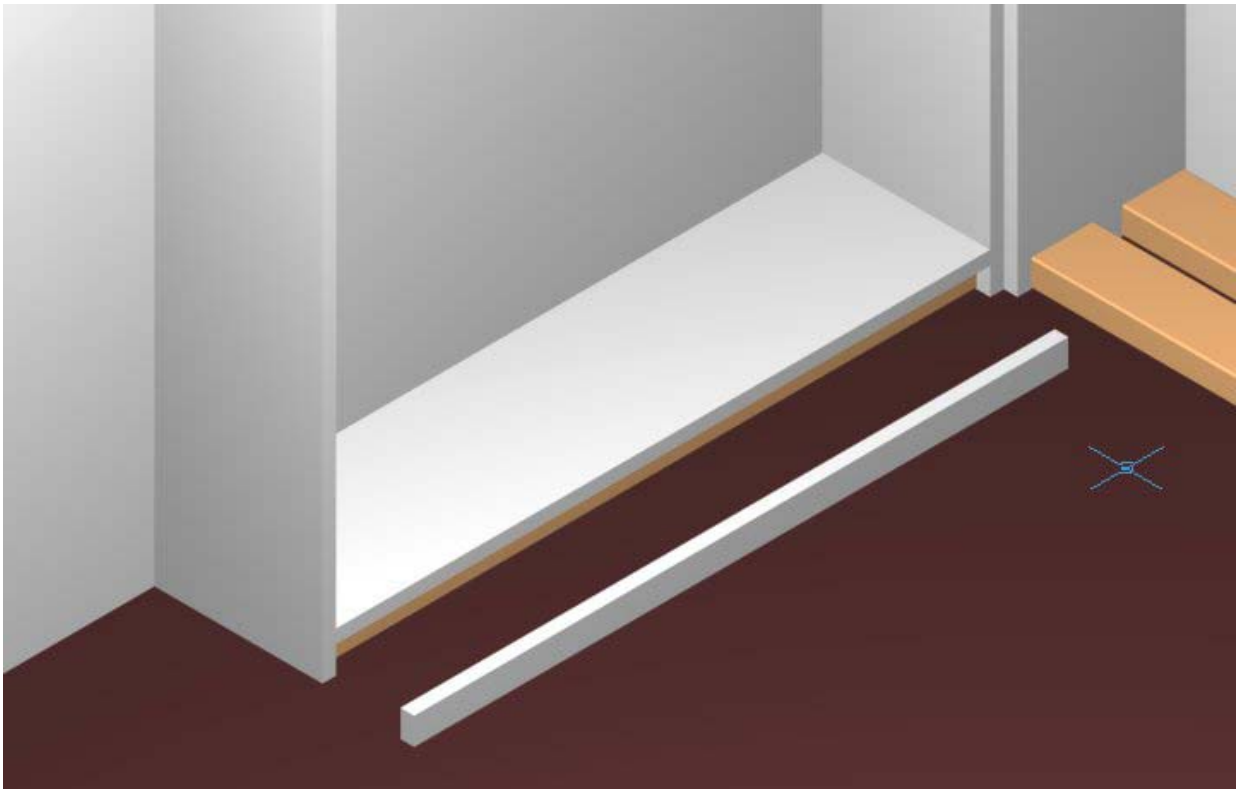

Figure 2.8 – Assembling Bottom Shelf with the Front Cover Plate about to be Inserted

Next, using wood screws, we attach the bottom shelf and the top cover. In addition, we have a white cover plate that is a 1 × 2 × 36 inches long shown in Figure 2.8, which nails to the front of the 2 × 4 stud to box in the rough looking boards.

We box in all of the 2 × 4 studs, making a bottom shelf and using a shelving board as a cover panel. The small front cover plates give the customer a continuous finish and the bookshelves appear as a built in assembly. Next, we will add the shelves that are set for 12.75 spacing. Even a full sized 8.5 × 11 book will clear the shelf with an each to spare. Before we insert the finished shelves, we place the steel shelf clips into the mounting holes that were predrilled in the sideboards.

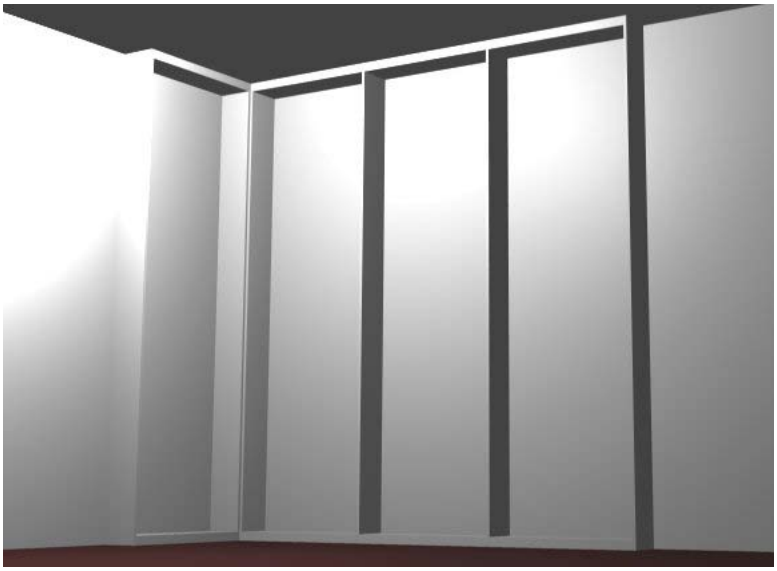

Figure 2.9 – All of the 2 × 4 Studs Boxed In

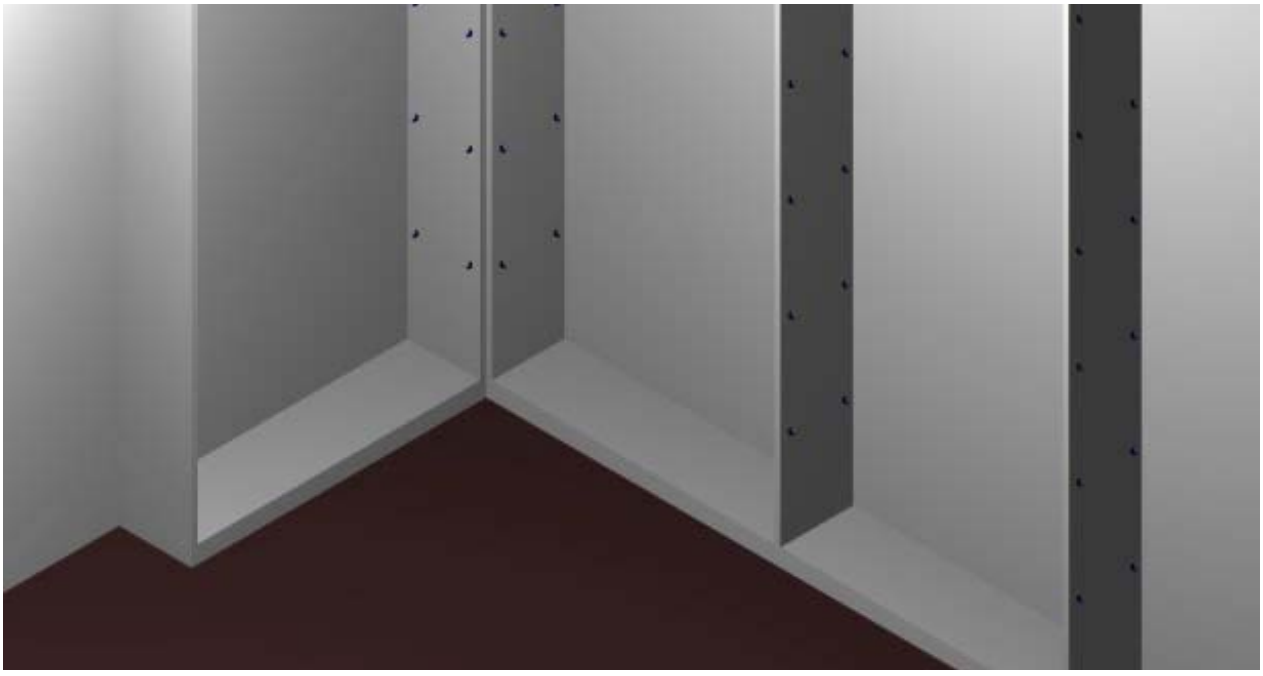

Figure 2.10 – Placing Shelf Clips into Pre-drilled Mounting Holes

There are many techniques to hold a shelf, but the only one we do not recommend is using plastic hardware. Remember shelving units can hold hundreds of pounds of books and many plastics lose their strength quickly over the age of the plastic. We cannot go wrong with using a steel clip that was properly plated to prevent corrosion. Check the safe loading specification on any clip purchased. Run a both a strength and failure test periodically on any design to verify

the strength calculations. If we change suppliers, rerun the calculations and the test so both the customer and our organization is confident the mounting hardware can sustain the load. Insert the mounting clips as shown in Figure 2.10.

When the shelves are put in place, the assembly will look like figure 2.11. Only the bottom tab of the mounting clip is visible to the public. The customer can request to have the typically silver or gold clips painted to match the color of the assembly. Most of the units we build will never be adjusted, so we permanently attach the shelves in position using a small finish nail. As the nail head comes closer to the wood surface, we use a nail punch to sink the nail into the wood.

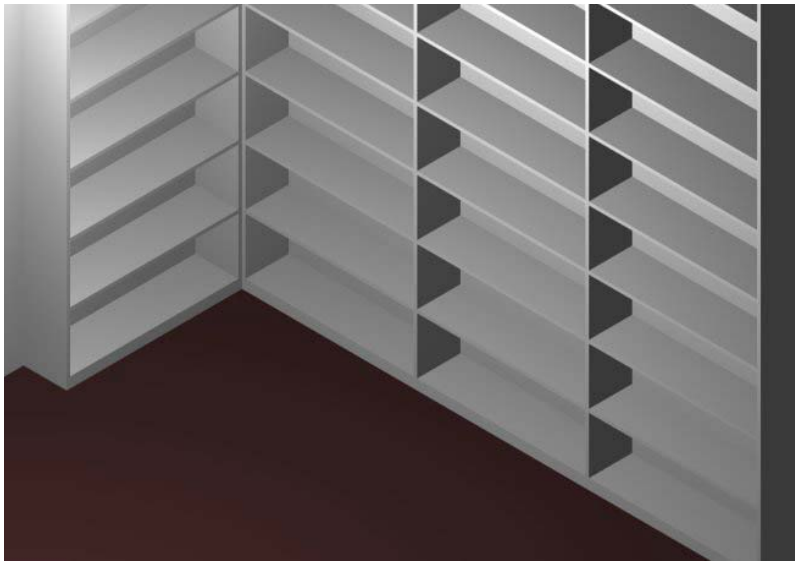

Figure 2.11 – Inserting the Finished Shelf

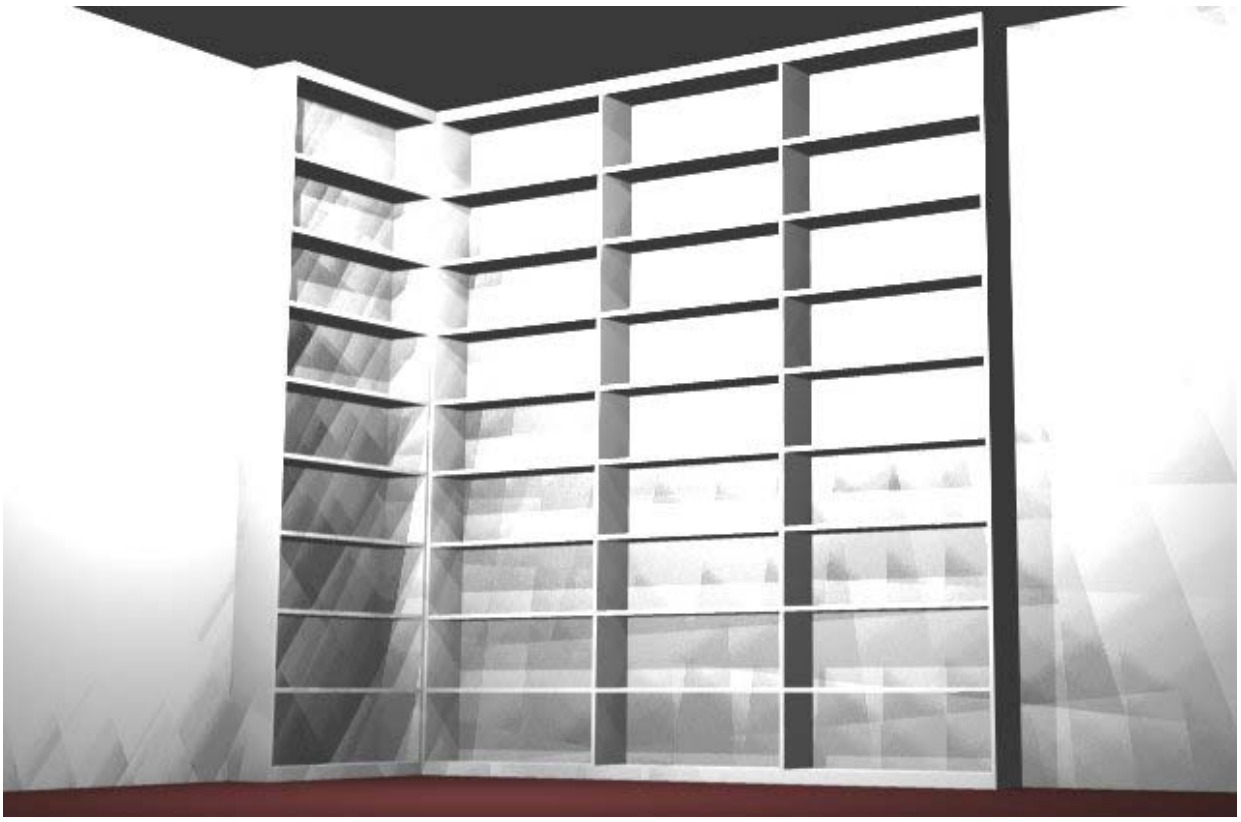

Figure 2.12 – Assembled Bookshelf

Now we are going to caulk the assembly. Place the caulking tube into the caulking gun and using a utility knife, cut the tip of the tube at an angle. Squeeze the trigger of the caulking gun until the caulking starts coming out. When we wish to stop the flow of caulk, push the button on the back of the gun to release the plunger. We use a clean wet rag to remove excess caulk and have plenty of work clothes to do the work.

Starting at the top of the assembly, caulk all joints where wood meet wood. Use a wet finger or cloth to rub caulking in and take off the excess. We wipe the excess of our finger or use a new portion of the cloth each time. Clean the tip of the tube each use. Let the caulk dry for 2 to 3 hours. Check the assembly again while dusting, for misses in cracks and nail holes that need filling. Remember not to caulk around the removable shelves.

After caulking is dry, we are ready to apply the finish coat. Put a drop cloth around the assembly. Open the high gloss enamel paint can and stir thoroughly according to the manufacturer directions. Pour the paint into the paint pan and wipe the side of the bucket with the paintbrush. Start painting the bookshelf assembly from top to bottom and from left to right. We need to do the entire inside surfaces first, then the outside surfaces. Do not put paint on too heavy to prevent runs and drips. This should be the last coat of enamel.

Put the remaining paint back into the paint can and seal the can for later use. Wash the brush and roller in warm water until and dry the tools thoroughly.

Let the bookshelf assembly dry for at least 24 hours before placing any books on the shelves.

Inspecting the Assembly

Inspection of any finished assembly is necessary to guarantee our and the customers satisfaction. Shine a light close to the shelving units to help to see the surfaces better.

Check for the following features:

- Look for any paint runs
- Make sure the paint has the same coloring all over – no heavy spots
- Check for cracks in the paint or sunk in nail holes
- An entire area that may have been missed during the final coat

In many cases, if we have missed an area or have imperfections on a board surface, the entire board needs to be repainted.

*** World Class CAD Challenge 6-100 * - Open a new file in your CAD program. Draw each component of the bookshelf in 3D. Make a part drawing for each component showing dimensions and finish notes. Build the assembly drawing. Make an assembly drawing showing dimensions and bill of materials. Add complete notes, including steps to finish the assembly. Do not forget inspection notes.**

Continue this drill multiple times using the steps we have learned, each time completing the drawing under 15 minutes to maintain your World Class ranking