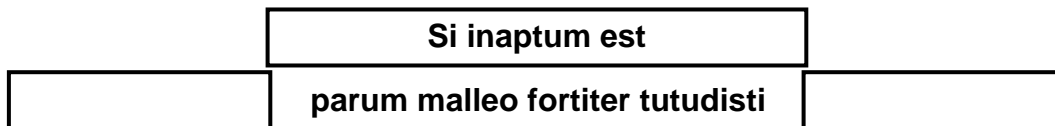


How to Build a Flat

An Illustrated Guide

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Amateur Theater Division



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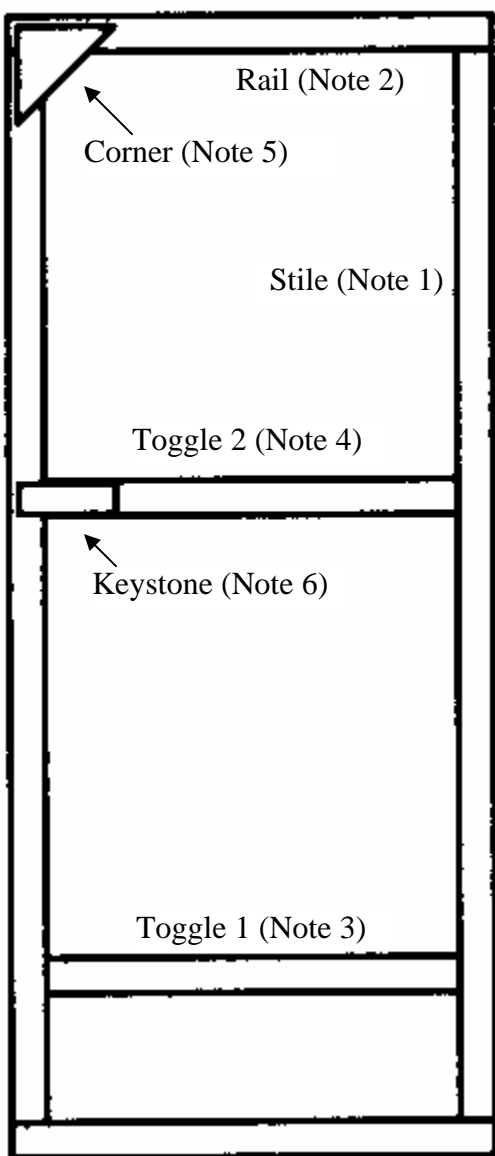
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Building a flat

Every detail is important because stock flats have to be used again and again: They must be rugged but also lend themselves to “finish” work when built into a set. Insist on good craft, and check it over and over.

Hard or soft? It’s more difficult to face a flat with muslin than it is with sheet material, but (a) it makes a lighter unit and (b) there may come a day when we don’t want to use tropical hardwoods any more. For the moment, we make them hard. The face can be quarter-inch plywood (stiff but miserably heavy), lauan door skin (stiff and light but somewhat brittle), or 5.2 millimeter lauan plywood (stiff, intermediate in weight, rather forgiving).



Here’s a drawing of the frame for a flat measuring 4’0” wide by 9’6” tall. I already said every detail is important, so I’ll accompany the drawing with notes.

1. Two stiles required. Nominal length is 8’11”. Adjust the length if the lumber you use for rails is wider or narrower than 3½” (it often is). For stock flats we use 1x4, grade “No. 2 or better,” picked on the following criteria (most important first):
Straight (no warps, bows or twists)
No splits
No weepers (sap on the wood surface)
Few ugly knots
No abrupt changes in grain direction (which will soon become splits)

2. Two rails required. Length is 4’0”. Same stock as for stiles.

3. The face material is only 8’ high, so we use one full height plus a second piece 1’6” high. The joint where the two face pieces come together has to be supported by a toggle. Nominal length is 3’5”; adjust this if the stiles are wider or narrower than 3½”. The **center line** of Toggle 1 should fall 1’6” from the bottom of the frame. The **center line** of Toggle 1 should fall 1’6” from the bottom of the frame.

4. We include Toggle 2 to support the face material and keep it from drumming. Nominal length is 3’5”; adjust if the stiles are wider or narrower than 3½”. The center line of Toggle 2 should fall 4’0” from the

top of the frame. This measurement is not sacred, but it’s desirable to have all the stock flats pretty much alike, so go ahead and measure it. Toggle 2 may be omitted in units less than 2’0” wide.

5. Four corners required. They are cut from ¼ inch plywood. The drawing shows one 9.6” on a side, which may seem ridiculous. An 8” corner is OK too. You can cut a sheet of plywood into five strips 9.6” wide or six strips 8” wide (and then cut the strips into triangles).

6. Four keystones required (only two if you are omitting Toggle 2). The word “keystone” is historical. This is neither a key nor a stone. As drawn, it is ¼ inch plywood, 3” wide by 9.6” long, but of course 3” x 8” is OK. Tapered is OK too (fat end out). Important: The long way of the keystone **must** run the long way of the original sheet of plywood. If all your plywood is already cut into triangles, it’s OK to use corners in place of keystones.

One sheet of plywood will yield corners and keystones to build roughly 12 flats. Facing a full-width flat takes one sheet and one-fifth of another one; if the width is less, you need less.

Bill of materials

For a flat 4’0” wide by 9’6” tall you will need:

1x4–10’ (see Note 1 for grade)	2 sticks
1x4–8’ (ditto)	2 sticks (reduce if omitting Toggle 2)
Plywood ¼ inch	4 corners, 4 keystones
Facing material	1.2 sheet
Drywall screws, #6 x 1 inch	approx. 72 each
Drywall screws, #6 or 8 x ¾ inch	approx. 32 each

Laying out the frame

Measure and cut the frame lumber and lay the pieces out on the work surface roughly as they will come together. It is useful to clamp or screw one stile to the surface. Collect your corners, keystones and 1 inch screws.

Tools required:

Screw gun with pilot and countersink bit (one per person sharing the work)
Framing square (ditto)
2 steel measuring tapes

Assembly: Step 1

Remember, I said every detail is in here for a reason. I’ll try to explain why in each case.

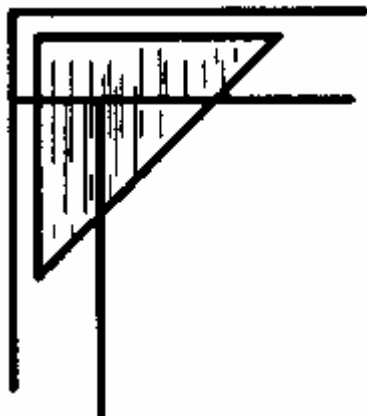
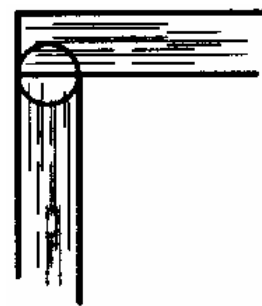
Lay one rail against one stile and use a framing square to get them perpendicular. Lay a plywood corner on the joint and drive a screw into each piece of lumber. Apply the framing square again, adjust, and drive the rest of the screws.

—Details:

1A. Plywood connectors must stand in 1 inch from all *outside* edges of the frame. Without this inch of clearance, flats will not fit together in corners of walls. If you need to, draw a line 1 inch in from the outside edges and make sure the plywood doesn’t transgress over the line (but it should come close).

1B. There is only *one* right way to lay the plywood. The drawing at right shows a butt joint. You see lots of grain lines in each piece of lumber.

Ignore them. Only one thing is important about the butt joint: which way the joint itself runs (heavy line inside circle). You are going to use this joint line to set your plywood every time you connect two pieces of the frame. Sometimes it runs left to right, other times top to bottom. Get used to noticing which way the joint line runs. In the drawing, it runs left to right.



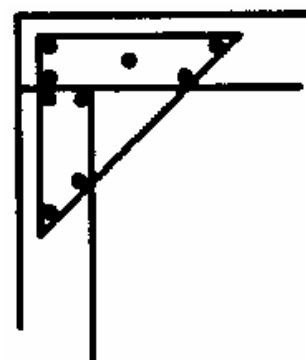
The drawing at left shows a plywood corner correctly laid down to make a butt joint. The plywood has a surface grain—the same on both faces—and this grain **is** important. Notice that the joint line (from the first drawing) runs side to side while the plywood grain runs up and down. The grain of the plywood must always **cross** the line of the joint.

Test yourself: The drawing at left shows a corner of the frame. At the joint where Toggle 1 meets the middle of a stile, which way does the joint line run? Which way should the plywood grain run in order to cross it?

You should also notice that the plywood lies 1 inch back from the outside edge of the frame.

Why so picky about grain and joint lines? A flat will never be strong, but we can make it fairly stiff. The plywood has more stiffness in one direction than it does in the other. When we lay the joint up as shown here, we're taking advantage of that extra stiffness to make the joint rigid. If you don't believe me, build a flat with plywood grain parallel to joint lines and try picking it up. You'll hear alarming creaks and groans and notice weird bending movements. It matters!

1C. There's more than one right way to screw the plywood down, but here is a very good one. It's called "5 and 4" because you put five screws into one frame member and four into the other. Every angle of the plywood gets a screw (within about an inch from the very tip). The idea is to set the screws as far apart as you can, in order to keep the joint from twisting or warping. (Some carpenters use 7 and 5.)

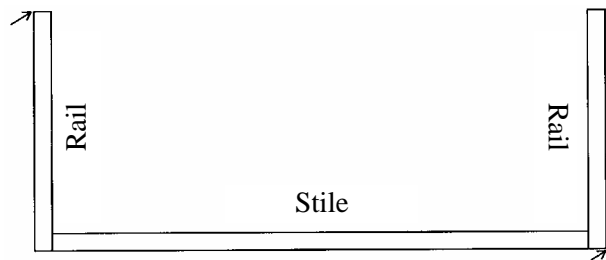


1D. Use 1 inch screws to fix the plywood on the butt joints. For strength and safety, the heads must be driven down flush to the plywood. Use a countersink bit to prepare the holes, then drive down cleanly. It is OK if screw points stick through the other side of the frame.

Shorter screws will not give a solid grip. Longer ones will stick through too far and get in the way of facing the flat. Use 1 inch screws.

You're finished with Step 1. Use the framing square again to make sure the members are perpendicular; then you can move on to the next step. **The next flat you build will go much faster.**

Steps 2 to end:



Attach the second rail to the other end of the stile.

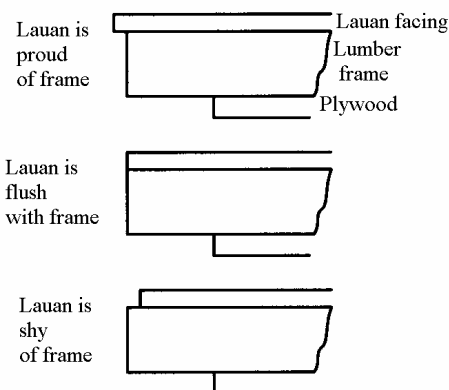
Now it's time to check the squareness of your frame. Take a steel measuring tape and drop it along the diagonal from arrow to arrow in the drawing at left. Then do the same on the other diagonal. The two measurements should be

close to each other. A difference of a quarter-inch is next to impossible to see in the finished work, but a difference bigger than that will interfere with putting the face on your flat. You may need to release one joint and resquare it to get the diagonals to come out equal.

If your diagonals are OK, the second stile will now fit properly. After installing it, measure the positions for the toggles and install them in the same way. If you measured and cut all the members correctly, and you did, every piece should fit nice and flush with the others. Don't accept air gaps, and don't shorten toggles that don't seem to go. Pull or whack the frame till everything fits.

Check your diagonals once again. If you secured the first stile to your work surface, this is the time to release it. The frame should *feel* rigid when you pick it up.

Turn the frame over and lay the full sheet of lauan on it. The lauan has a beautiful side and a less beautiful side; the beautiful side goes out where the people can see it. Make sure the frame is at least as square as the sheet material. The lauan must not stand "proud" of the frame edge; it's OK if it is an eighth of an inch "shy," but proud will get in your way later. See the drawing at right. You may have to trim a sliver off one side of the lauan.



Draw an imaginary line around the outside edge of the lauan facing, about 2" in from the edge. The $\frac{3}{4}$ inch screws will lie on that line. Put one in each corner and check to make sure the sheet is not crowned in the middle or cocked on the frame. Now it's important that these screws not stick up above the lauan surface; they simply can't be concealed later on. And $\frac{3}{4}$ inch screws will not drive themselves, no matter how you hold your mouth. You **must** drill pilot holes and countersinks. Carefully prepare holes on your imaginary line spaced 12-16" apart and drive the screws. Get the heads flush with the lauan facing. Secure the facing to both toggles as well as the frame.

Cut the piece of lauan you need to complete the facing, and attach it in the same way. Get the joint between sheets as clean as you can. Remember to make the facing shy or flush, never proud.

Paint the back and edges of your new flat. Black is nice. Backpainting has two purposes: to impede the flow of air to the wood if the unit is exposed to flames, and to avoid tempting the Talent to write on the scenery. You're done.