How Do You Make …

Doors and Windows

Doors and windows are fairly complex structures. They have as many different looks as there are designers drawing them, but they do tend to have some properties in common. The parts that make up a door use the same woodworking names as a flat does: the uprights are stiles, and the horizontal members are rails.

Doors and windows may be either built as an integral part of a wall structure or constructed as separate units. Sometimes it is best to simply attach all of the parts to the wall, especially when hard-cover flats are concerned. If the show must break down either to tour or because it has multiple scenes, having a separate door unit can be quite cumbersome. It is probably easier to move the wall with the door in it. If the wall is double-sided, it would be very difficult to build a door and frame that are removable.

Much of the time, independent units are more cost-effective—especially for a show with a single box set. Doors (or windows) can be removed from one wall and reused in another. Eventually a stock is built up that can be recycled and will cut costs in the long run. If your theatre has a main season and a lower-budget "studio season," the lower-budget shows can definitely benefit from being able to pull scenery from stock. Of course, you will need ample storage space if you plan on keeping everything you build.

Even if the frame is built as part of the wall structure, you will still need facings, trims, and stops. You can use many of the techniques shown in this chapter to build the frame as a part of the wall. The sections on hanging a door will work with any type of construction.

THERE ARE MANY DIFFERENT TYPES OF DOORS

Doors

There are two main parts to a door: the slab or *shutter*, and the *frame*. The first thing to determine in designing a door system is the size of the slab and the type of motion the door will have. Doors can be hinged for a variety of motions, using standard butt hinges, double-action hinges like a kitchen door, folding doors, or as a sliding door. A majority of doors wind up being plain old butt-hinge doors.

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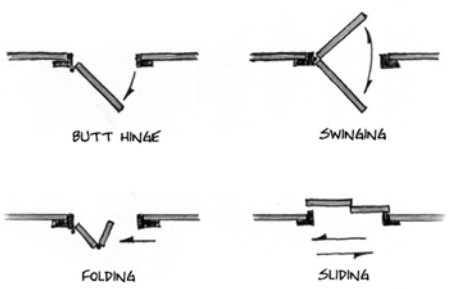
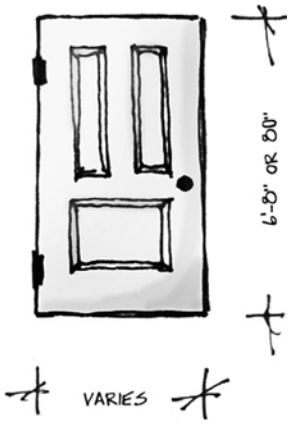


TYPES OF DOOR MOTION

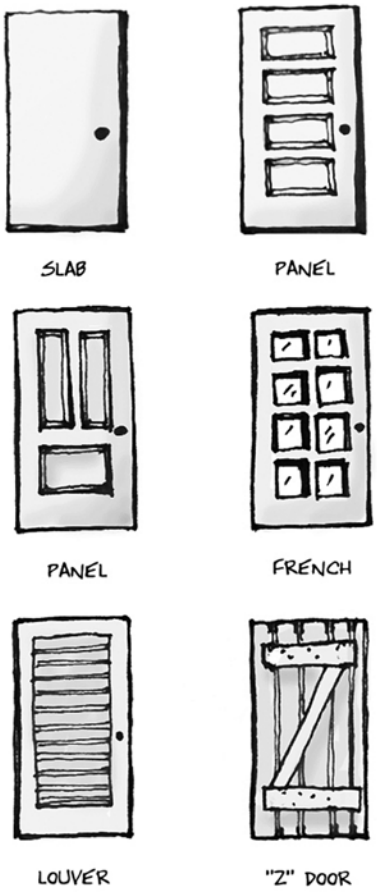
It is quite common to buy or recycle a door and then build the frame that surrounds it. Most factory-made doors are either 7′-0″ tall or 6′-8″ tall. The standard modern size for a residential door is the smaller 6′-8″ height. Exterior doors, commercial doors, and antique doors may all be the taller 7′-0″ size. Some doors that were originally constructed for a special project may be considerably larger, but the two heights mentioned account for the vast majority.



STANDARD SIZE
OF A MODERN DOOR

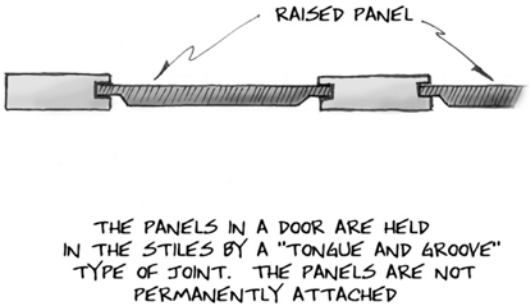
The width of a door is given in feet and inches. The narrowest you usually find are 1′-6″, and the widest commonly manufactured are 3′-6″. Doors come in even inch widths like 2′-4″, 2′-6″, 2′-8″, and so on. Do not be surprised if you run across an old used door that is a strikingly odd measurement, for it may well have been cut down at some point in its life, or it could have been originally manufactured to fit an odd-sized hole. Back in the day, building a house was a much less scientific endeavor than it is now, and it is quite common to find salvaged Victorian architectural details with unique measurements.

A *slab door* is flat on both sides. Frame and *panel doors* are made by constructing a frame of stiles and rails, with panels inserted to make the door solid. *French doors* are built with windowpanes for a light, airy look. *Louvered doors* have an interior made up of slats so that air is allowed to pass through. *Z doors* are made of vertical planks and are held together by braces that form a Z.



The names of the parts of a flat that we use in the theatre were adapted from the names of the parts used to construct a panel door. It is not possible to build a door that is one solid piece of wood. Of course, trees don't generally grow that big, but even if they did, the resulting structure would be very unstable. You have seen how an ordinary 1 × 12 tends to cup out of shape because of the width of the board and the way that the growth rings dry out. Imagine how much cupping would occur if the board were 36 inches wide. Also, you recall how wood tends to swell across the grain when the weather is humid. If the door were really one solid piece of wood with the grain running vertically, it would

tend to shrink or swell across its width a tremendous amount depending on the humidity. So the proportionally slender rails and stiles are used to form the outer structure of a door, and the much wider interior panels are loosely joined inside a mortise, so that they can change in size without affecting the rest of the door.



Green Ideas Tip Box

Doors and windows are difficult and complex structures made from many individual parts. It isn't really possible to salvage any materials from them, because the parts are too small. So it makes sense to save them as individual units and reuse them.

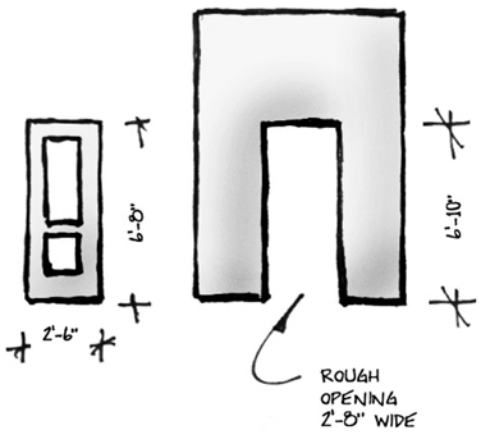
Making Door Frames

Although you may often buy or salvage the actual door, it is very rare to find a door frame suitable for stage use. They must almost always be constructed from scratch. Doors are removed from the building during demolition, but the *door frame* is an integral part of the structure of the building. New doors are often sold prehung, so that the jamb or frame comes with it. Unfortunately, these factory-made jambs are really not suitable for stage work, because they are entirely too flimsy and rarely have the sort of style that the design calls for.

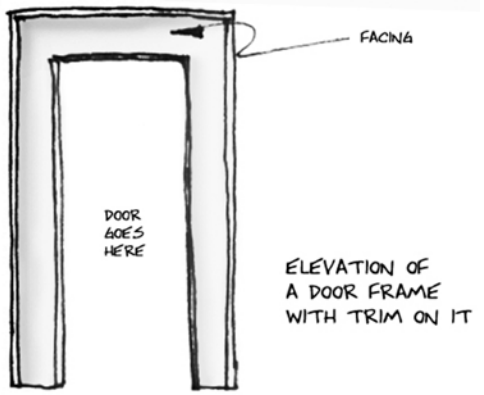
My method of building a door frame is based upon making it independent of the wall it fits into. Strips of plywood are laminated together in a way that creates a very strong structure. It works equally well with settings of either soft-covered or hard-covered flats. If you are building a frame that is permanently connected to a hard-covered wall flat, you can use many of the same techniques, but you will not need to laminate the facing trim, because the flat already provides a rigid frame structure. If you permanently connect the door frame to the wall, you won't be able to salvage as much for reuse.

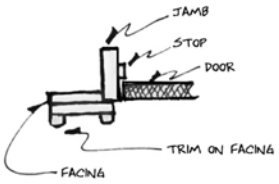
The narrative used to describe this construction method is quite detailed. Many drawings are included to illustrate the *laminating* method. Laminating plywood parts is a great way to construct all sorts of things, so part of the aim here is to get you acquainted with that style of construction. Laminated plywood is very strong and quite stable.

Assume that the door used in the demonstration is 2′-8″ wide and 6′-8″ tall. One of the first things to do is to determine the size of the *rough opening*. This is the hole that must be left in the wall flats where the door will be placed. An independent frame requires that the rough opening be at least 2″ wider and 2″ taller than the shutter used in the frame. Add the numbers to get a rough opening size of 6′-10″ in height, and 2′-10″ in width. These dimensions should be used when working up a cut list for the wall flats. It does not matter whether hard-covered or soft-covered flats will be used. The rough opening can actually be several inches larger and still work if the frame facing of the door jamb is wide enough.

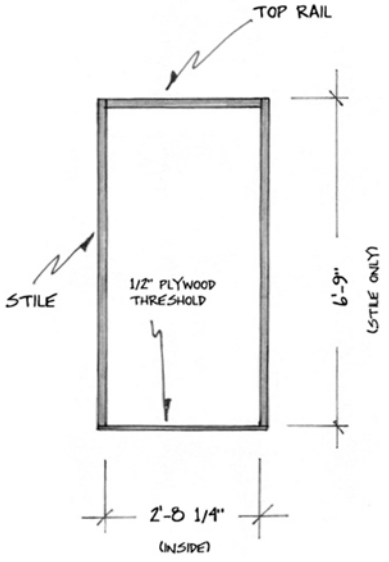


The *door facing* is constructed of overlapping strips of ½″ thick plywood. The door jamb is built of 1 × 4 white pine, although you can use plywood for this also if it is on hand. Be sure to use ¾″ thick stock, because the ½″ ply used for the facing is not strong enough. The facing is usually accented with trim selected by the designer, but the basic structural parts involved are the facing, the jamb, the stop, and a threshold piece across the bottom that will help the door keep its shape.





PLAN VIEW OF SECTION THROUGH DOOR AND FRAME



CUT LIST
JAMB ONLY

1X4	1/2" PLYWOOD 3" WIDE
2@ 6'-9"	1@ 2'-9 3/4"
1@ 2'-8 1/4"	

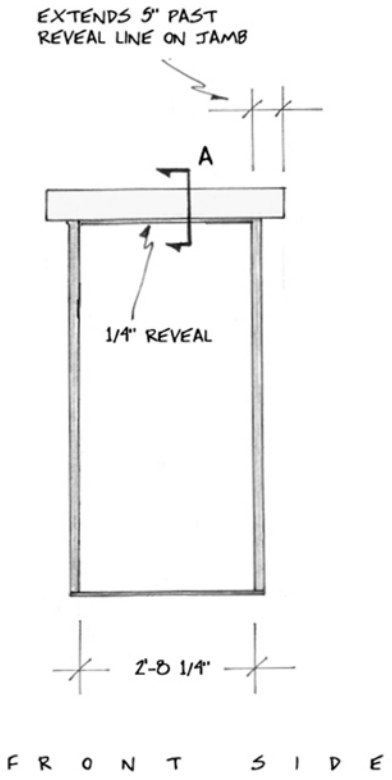
Begin your door frame cut list with the jamb. The two uprights need to be an inch longer than the door itself is tall. The added inch will accommodate the ¾″ thickness of the top rail, with an extra ¼″ space left over to give the door room to operate. That is really a minimum. If you think that the shutter part of the door may have problems opening, give yourself a bit of extra room. A house door needs to fit closely so that the insulation will be effective, but that is not a problem on a stage door. The top rail should be the width of the door plus ¼″.

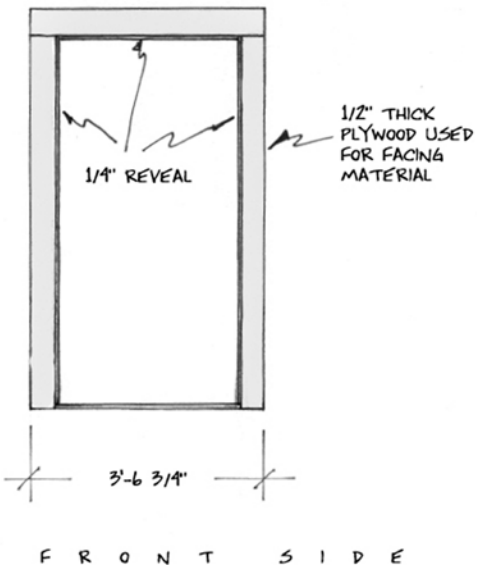
That extra quarter-inch provides enough leeway for the door to swing without having to worry about the thickness of paint and other such hidden dangers. It will also make it unnecessary to mortise a space in the jamb for the hinge, which can be a very time-consuming process. The section of ½″ plywood that forms the *threshold* extends all the way from the outside of one of the stiles to the outside of the other. Hence it should be 1½″ longer than the top rail. It is best to assemble the jamb before going on to the facing.

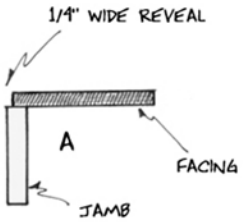
Sometimes, having a threshold across the door opening can be a hazard to actors, or a problem if something like a wheelchair must be rolled through the doorway. You can omit the threshold and still use this method, but the resulting structure will not be as strong. Most of the time, the ½″ height of the threshold is not enough to cause major problems unless you are using it in conjunction with a hard-covered flat that already has a framing member across the bottom.

This method of constructing the facing requires that it be made of two distinct layers. The first is connected to the front of the jamb. The width of this facing is determined by the style of the trim involved. Modern doors may have a casing less than 3″ wide, but most period doors require something considerably larger. This example is of a large period molding trim that will be 5″ wide, so the width of the facing piece is 5″. Insetting the facing ¼″ from the inside of the jamb will give the barrel of the butt hinge someplace to go. Mounting the door hinges is covered later in the chapter. Leaving a space also creates an additional *reveal* around the perimeter of the door. Generally speaking, the more reveals (or shadow lines) that are on the trim, the more complex it will appear to be.

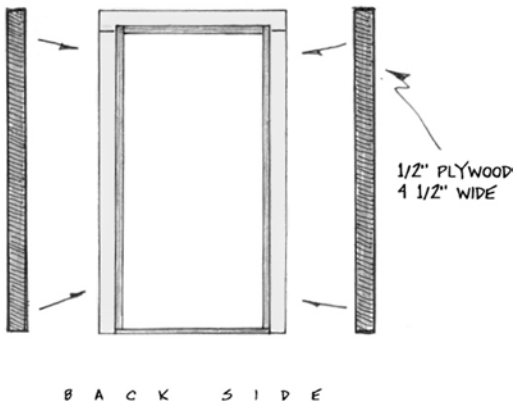
To figure the length of the top piece of facing, measure the width of the inside of the door jamb and add 10″ inches, 5″ for either side. Now add ½″ to this total, which will account for the ¼″ reveal that will be left all around the door jamb. Measure the inside height of the jamb and add ¾″ to that measurement to get the total length of the two upright facing pieces. Again, ¼″ is for the reveal, but the remaining ½″ is for the thickness of the threshold. Cut the pieces from ½″ plywood.







SECTION THRU
DOOR FRAME

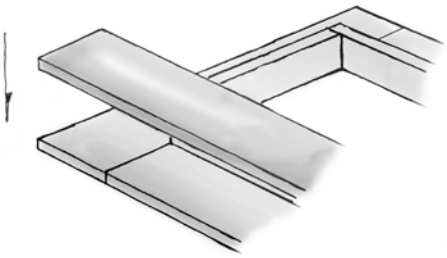


1/2" PLYWOOD LAMINATED
TO THE BACK CREATES
A VERY STRONG LAP JOINT
THAT LOCKS THE PIECES
TOGETHER

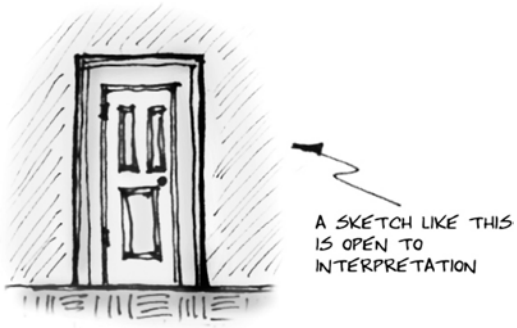
Once again, it is best to attach these parts before going on to the next batch, at least until you are familiar with the process. After that you can save time by cutting all of the parts for all of the doors and windows at one time. Remember to inset these pieces ¼″ from the inside of the door jamb. Gluing is essential!

The next series of parts are used to strengthen the door frame, which as you can no doubt tell is very wobbly at the moment. The second layer of ½″ ply gets laminated to the *back* side of the facing pieces that were just installed.

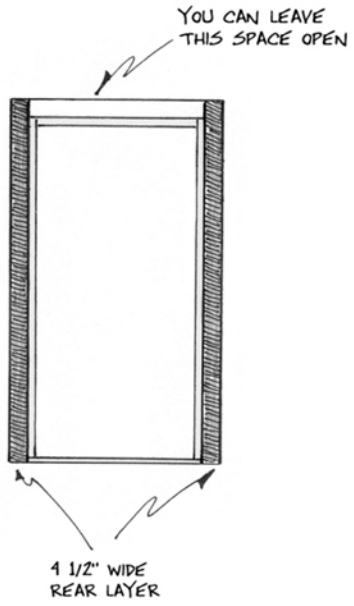
Overlap the joints at the top corners to reinforce them. It is amazing how strong the frame becomes when these parts are added. If you measure the back of the facing piece you discover that it is 4½″ wide, because ½″ of the original 5″ width was used to connect the facing to the jamb. Measure the length of the facing from top to bottom to get the length of these two side pieces. Not only do they do a great job of stiffening the corner, they also make the facing an inch thick, so it appears more dimensional. Square the frame before laminating the parts.



LAMINATING THE REAR LAYER CREATES A VERY STRONG JOINT

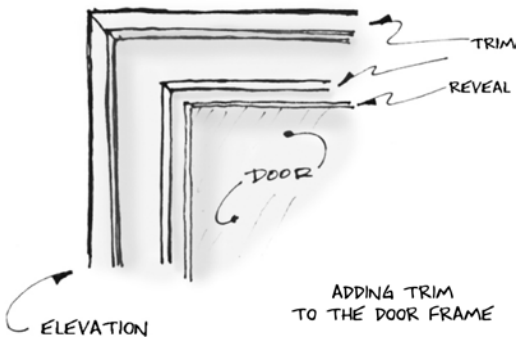


If the audience will not be able to see the top of the door, it is not really necessary to fill the gap across the top. This top section does not cross any joints, so it has no structural function. You may wish to fill in that space if it will make it easier to get the trim on the front.

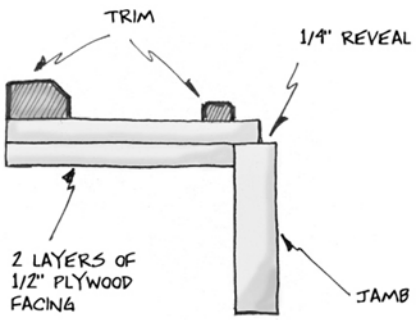


The next procedure is to apply trim to the door frame. The trim is what will give the door its style. Until this point, there is not much difference in the construction method used for one type or another, excepting the basic width of the facing, which is generally larger for an ornate style. From this point forward the process is dictated by the design provided by the scenic designer. Here are some approaches to producing a few of the most common styles. Quite often, the clarity (or lack thereof) of a design will leave some decisions about the exact nature of the trim to the discretion of the technician.

The most straightforward approach is simply to band the edges of the facing with some variety of small trim. It is amazing what even the most easily produced stock will add to the appearance of a door. I think what is important is that there be something there to catch the light and reveal a shadow, but the exact nature of the trim is not so important. It is generally better to use something fairly large and rectangular around the outside edge, and a smaller, softer-edged trim toward the inside.



The outside trim should be attached flush with the edge to create a thick slab to cover the intersection of any baseboards or chair rails. You can locate the inner trim a small distance away from the edge to create an extra reveal.

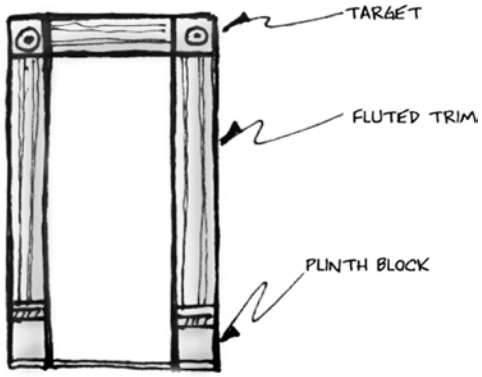


These trims will need to be measured and cut to fit. If they are just rectangular in cross section, they can be left with 90-degree angles. If they have any other profile, it will be necessary to miter cut the corners. It is easiest to cut a 45-degree end first and then to cut the 90-degree end to length. The 90-degree angle is easier to line up in the saw. It is best to cut a piece, put it on, cut a piece, put it on, and so forth, because it is less confusing and gives you a solid, physical position to mark from. Marking the pieces by holding them up to the door frame is more accurate than measuring and is less prone to mistakes.

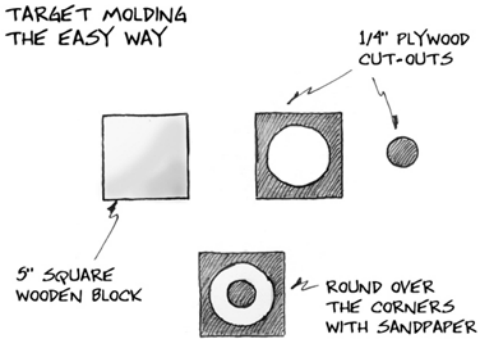
The outer edge of the door facing is now made up of a number of layers of different materials that are probably not exactly flush with one another. Use a belt sander to even things up a bit. After a rough sanding, fill any large holes with joint compound, and finish by hand sanding when the mud is dry. You will be surprised how much two or three minutes with a piece of 100-grit sandpaper can do. Easing the corners of your woodworking even a small amount will greatly improve the overall look of the work.

The Victorian *target* molding style is quite popular, especially if your theatre produces classic American dramas. There are several ways of approaching it. The most obvious visible difference about this style is that the corners are not mitered, but rather square blocks, also known as targets, are used to cover the change in direction. All of the trim sections end with a 90-degree angle. There is a target block in both of the top corners, and a *plinth block* at the bottom of each side of the facing.

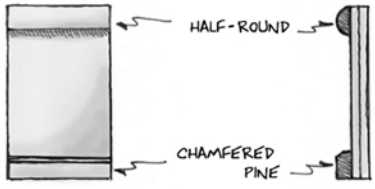
Making the target molds and plinth blocks is, as you would imagine, the challenging part of this assignment. Sometimes it is possible to purchase them from a salvage yard, or to find suitable reproductions on the internet. The target molds were originally turned on a lathe, and you can make exact copies that way from a pattern. But it is a time-consuming task. If you have even one example of a target you can use it to make a mold and then replicate the target using Bondo, auto body filler. Or you can use a router to simulate the carving that was formerly done on a lathe.



This simple method looks great from a distance and is very easy to put together. It uses thin layers of ¼″ plywood to simulate the carving detail. This is a "build up" rather than a "carve into" process. Cut out two plates as are described in the drawing. Mount them on a block of one-by that has been cut down to a 5″ square. Careful sanding of the edges of the plywood will round it over and help to create the illusion that the block is one solid piece.

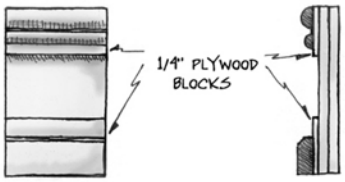


Originally, the plinth blocks were made by running a long piece of stock through a shaper to get the correct profile. That length of trim was then cut into 5-inch-wide pieces to match the width of the rest of the trim. The basic profile of a typical block calls for a trim strip at the top that sticks out somewhat, and it is easily simulated with some half-rounds.



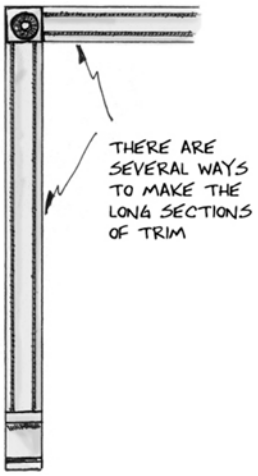
PLINTH BLOCK

To vary the style a bit, you can use more than one strip of half-round, or some other trim to increase the number of reveals. The beginning block should be the same width and thickness as the target mold and about twice the height.



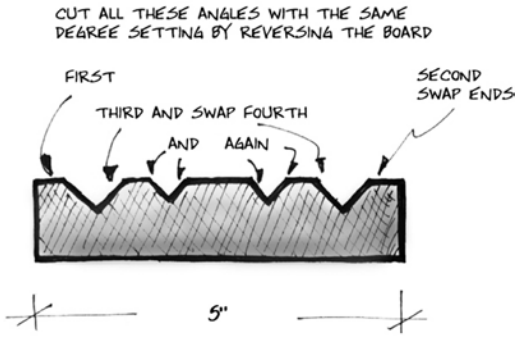
ANOTHER APPROACH

The basic run of trim between the blocks can be made either as a solid piece, or as a series of different strips. It is best not to make this too terribly complicated. The trim should be symmetrical from the center line. A round nose bit on a shaper table is an excellent way to create the rounded channels.

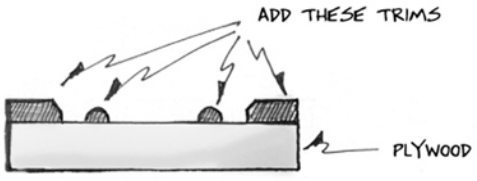


The table saw can be used to make V grooves, and if a shaper is available, it can be used to create beaded effects. Since the trim is symmetrical from the center, it is possible to make two passes with each setting of the saw or router table. Just turn the board 180 degrees, and make the second pass. Be sure to do all of the pieces of trim before readjusting the tool. Make all of the trim you will need at one time so that all of the pieces will match. It never hurts to make a few extras just in case.

A built-up method can also be used with these long sections of trim. Cut small strips of trim and apply them to the facing you've already assembled. If you are using this method, just be creative, but look for shapes that are in keeping with the feel of the original. The outside edges should have a larger, squarer profile than those in the center.

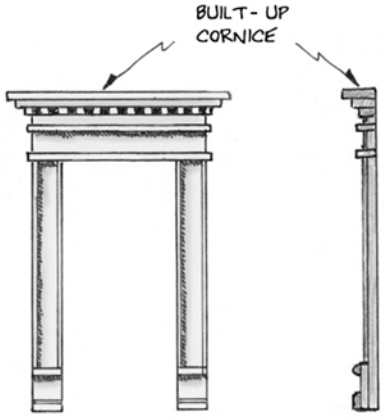


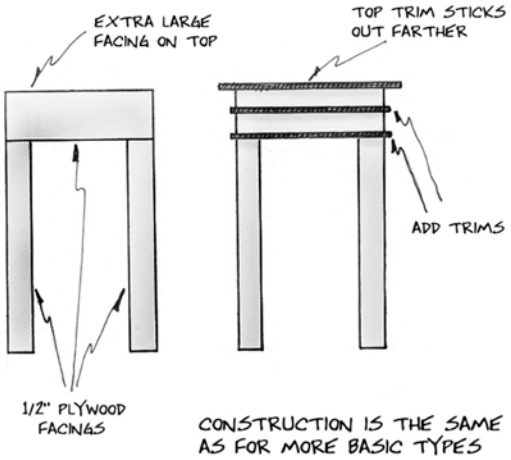
YOU CAN MAKE THIS TRIM ON THE TABLE SAW USING A REGULAR CIRCULAR BLADE. SET THE ANGLE AT 45 DEGREES AND SWAP THE ENDS BACK AND FORTH. READJUST FENCE AS REQ'D



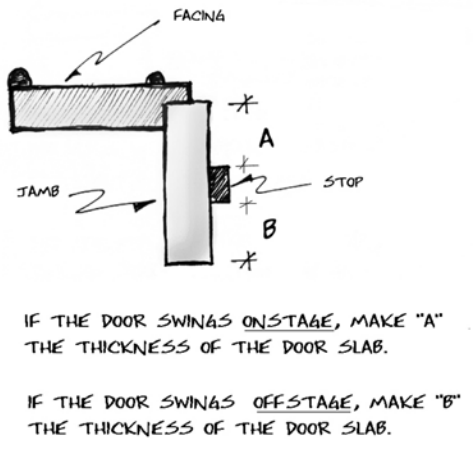
THIS VERSION IS MADE BY BUILDING UP TRIMS

Another popular type of doorway design uses a cornice molding at the top of the opening. The basic unit can be made in the same way as previously described. A section of one-by is used across the top as stop for the top of the *cornice molding*. If you let this stick out a bit, and finish it with some half round or other trim, it will become just another part of the molding. You can use one strip of trim at the bottom of the cornice and another one at the top of the door opening. If you would like for the cornice to be very large and grand, it is possible to build up the thickness of the top of the facing to increase its scale.

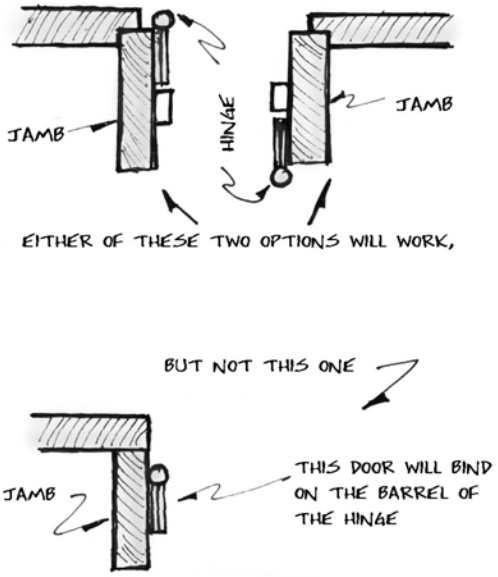




If your door frame will be used to hold a door hung with butt hinges, it needs to have a *stop strip* installed. This strip is generically $\frac{5}{8}'' \times 1\frac{1}{4}''$, but it often varies, for aesthetic reasons. The stop is intended to keep the door from swinging too far into the jamb, so the name fits. A butt-hinged door will not operate properly without one. If the door is to swing onstage, the stop should be placed with its onstage edge the same distance from the front of the jamb as the door is thick. Rip a scrap strip of plywood to the same width as the thickness of the door you are hanging. Use this plywood as a guide jig to mark the placement of the stop. A butt hinge will not operate properly if the barrel of the hinge does not extend past the jamb. It is not possible to hang this type of door in the middle of the jamb without a great deal of rather unattractive gouging of the wood.

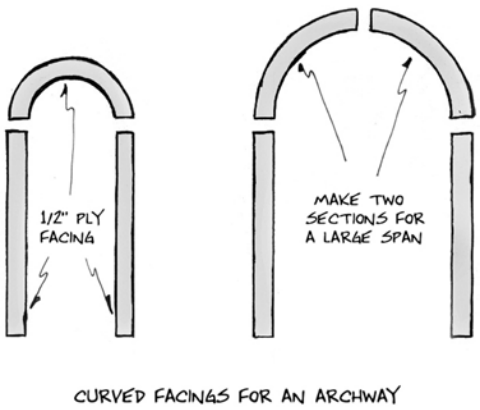


If the door is meant to open offstage, place the stop using the same method to measure and mark, but do that from the rear of the jamb instead.



Exotic Shapes

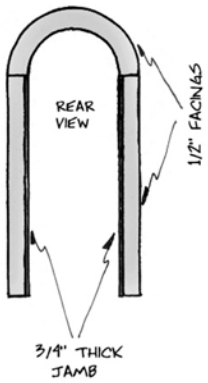
If a rounded top is required for the door, the frame design must be modified a bit, but the basic concept remains the same.



This style is easier to build if you begin by cutting out the facing first. Suppose that the width of the facing is to be 4″, and the door itself is to be 2′-6″ wide. It is of standard height, and the arch is Romanesque. Here is a drawing for the face frame showing how the parts fit together. The inside of the frame should be 2′-7″, which is large enough to accommodate a bent plywood reveal around the inside edge of the frame, with $\frac{1}{4}''$ added to ease door installation. You can mark the pattern on a sheet of plywood. If the size of the door is very large, it might make more sense to divide the arc into smaller pieces. This will save on materials.

STEP ONE

The straight part of the jamb can be cut to length from ¾″ × 3½″ stock. Measure the length from the bottom of the facing to the point where the curve begins. Subtract ½″ for the thickness of the threshold. The jamb and side facings can be glued and nailed together, along with the threshold.

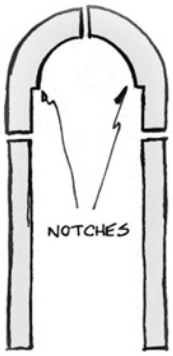


STEP TWO

The second layer of facing should be cut so that the joints fall at a different place in order to create a solid, laminated structure. Make the width of the back layer ¾″ smaller than the first one where the jamb is in place, but make it run all the way side to side along the part of the curve where you don't yet have a jamb.

At this point, the curve of the top will be stiffened and squared, just like the rectilinear unit shown earlier. The pieces are different shapes, but the process is just the same.

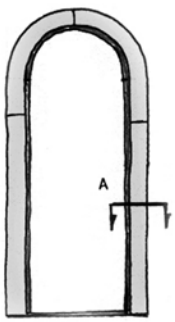
The curved section of the jamb needs a new approach to making it, because there isn't any way to bend white pine lumber that much. As you will recall, the opening was made 1″ wider than the actual size of the door. This was to accommodate the wood used to fill in the curved section but which also goes over the straight part as well. *Bending plywood* is made so that the grain in most of the plies is oriented in the same direction. As a result, it is not nearly as strong as regular plywood, but it is extremely flexible.



MAKE SURE THAT THE BACKSIDE LAYER HAS JOINTS THAT FALL IN DIFFERENT PLACES.

STEP THREE

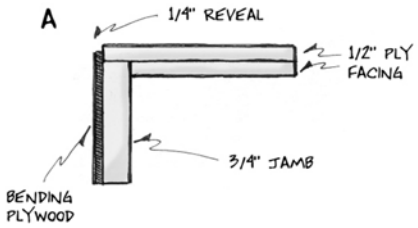
This type of plywood is available in two basic types. One has the grain running the length of the sheet and can be used to bend around tall, thin objects like a column. The other has the grain running across the 4′-0″ direction. This latter type is used to bend around larger, shorter objects like a barrel. Bending plywood is generally ⅜″ thick and is an excellent choice for lining the inside of the doorway arch. The *barrel* type of bending lauan will give you the longest strips to work with and is the best choice. If bending plywood is not available, ¼″ thick regular lauan or fir plywood will do the job if the arc to be covered is large enough in diameter. It is much harder to put on.



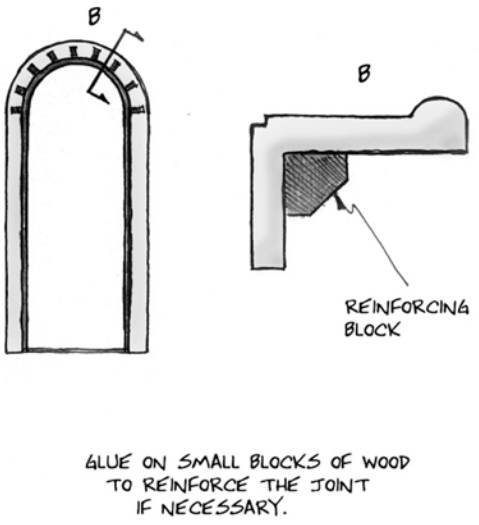
RUN A STRIP OF BENDING LAUAN AROUND THE INSIDE OF THE DOORWAY TO FINISH IT OFF.

STEP FOUR

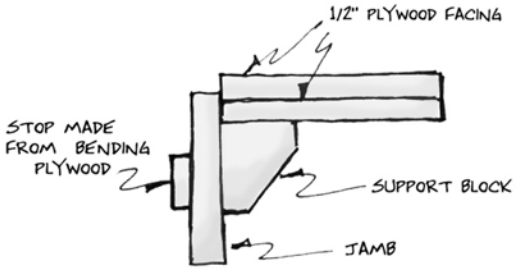
Rip several strips of ⅜″ thick bending lauan to 3¾″ wide. Glue and nail a length around the top of the opening first. It would be nice if the center of the strip is at the top of the door, but exact placement is not crucial. However, it is important that the ends of the strips extend past the point where the curved and straight sections join each other. This will impart extra rigidity to the structure. Be sure to use glue. The width of this strip is ¼″ shy of the actual thickness of the jamb in order to provide a reveal for the barrel of the hinge. Accordingly, make sure to flush it up with the *back* of the 1 × 4 jamb and then leave an even ¼″ space around the curved part.



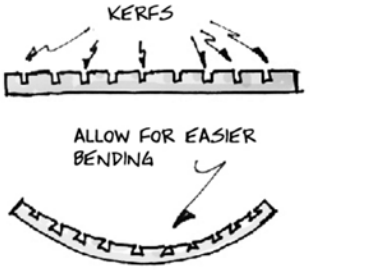
Cut two pieces of bending lauan to fit into the remaining gaps at the bottom of the door jamb. Glue and nail them into place. This completes the basic frame. If you feel that the unit needs to be stronger, add another layer of bending lauan to the outside of the curve, or use some small blocks to beef it up around the top where the bending lauan is unsupported. If you use support blocks on the back side, you will need to leave space for them in the rough opening you have in the wall.

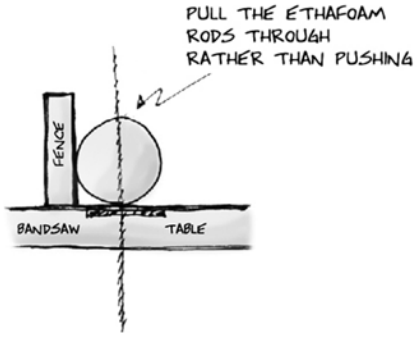


If a door stop is required, rip down a couple of 1¼″ wide strips of the bending lauan and attach them in the normal way. Using the bending lauan will make it possible to match the curve.

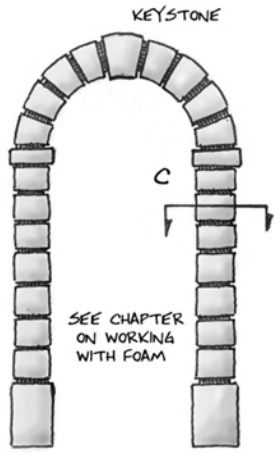


If trim is required around the outside edge of the face frame, it can be made from *Ethafoam rod* ripped in half or quartered on the band saw. The Ethafoam can easily be bent to any possible door diameter. If the door width is reasonably large, it may be possible to bend a piece of white pine around the outside of the frame. The chances are improved if the length of pine is kerfed prior to bending. This is done by cutting a series of slots into the board. Kerfing effectively reduces the thickness of the trim piece. With a thinner piece, the outside edge will need to stretch less, and the inside curve will compress into the kerf slots. This type of work requires considerable filling and sanding. If you have a curved top door that is not round, it is possible to cut out a narrow band of ¾″ plywood that matches whatever shape is required.



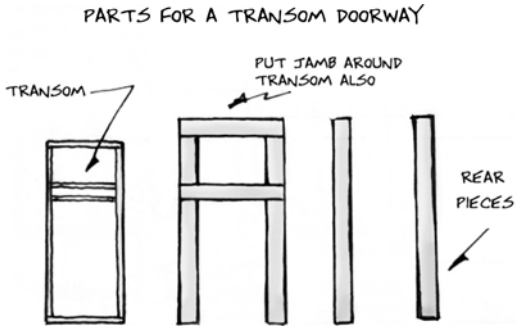


Perhaps your plans call for a stone archway. You can create that effect by covering the facing with a thin layer of polystyrene foam. Mark divisions on the foam to represent the stone segments and carve out the blocks.

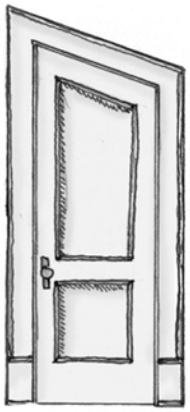


COVER AN ARCH WITH FOAM TO MAKE IT INTO STONE

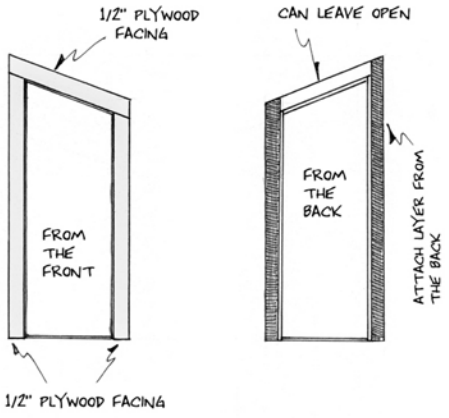
Here are some diagrams on how to add a *transom light* to a door frame. A transom is basically a small window on top of the door that allows for ventilation when the door is shut. You will need to build one of these if you do a play like *The Front Page*, or perhaps *Kiss Me Kate*. The resulting frame is considerably taller than a normal opening.



Here is a plan for construction of a door that must fit under a stairway and that is consequently slanted on the top. Perhaps it would work for *The Foreigner*, or *Something's Afoot*, or *Noises Off*. This door has a slant of 45 degrees, but the angle can be easily altered to fit a specific stairway. The construction method is the same as the previous types in that the face frame is two layers and overlaps in the corner, forming a lap joint. This is really the key to the method used for all of these examples. The shape and size of the doorway may change, but the basic construction style remains the same.



THIS DOOR IS DESIGNED TO FIT UNDER A STAIRCASE



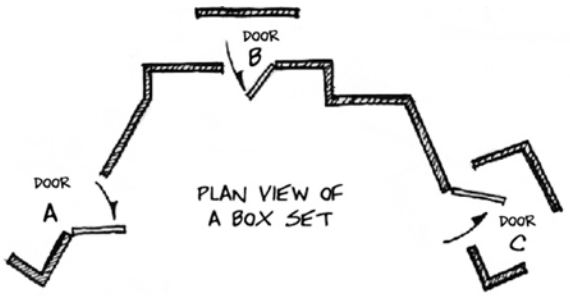
CONSTRUCTION DETAILS

Making the Doors

It is easier and less expensive to purchase doors than to make them yourself. Many panel door reproductions made from shaped hardboard with a hollow core are available. They are lightweight and inexpensive. Stage doors are generally meant to be painted, even if that means painting on a wood grain effect, so the fact that the doors are made of hardboard is not a problem. Architectural salvage yards are generally full of doors that have been removed from razed structures. There are times, however, when specific types of doors must be made in the shop, because the design calls for something unique.

First, a word about door placement. The direction a door swings is an important factor in the movement

of actors. A door that opens the wrong way makes it difficult for the action of a scene to take place. A home entry door almost always opens to the inside, so that a chain and/or certain types of locks may be used. The entrance door to a business almost always opens out to make sure that the exit will remain clear in case of a fire. Doors that open "on and downstage" can be very awkward because the actor is at first hidden. Doors that open "off and up" are very popular because they help to mask the area behind the door. Planning the movement of a door is a design responsibility, but you should have a basic understanding of how those decisions are made.



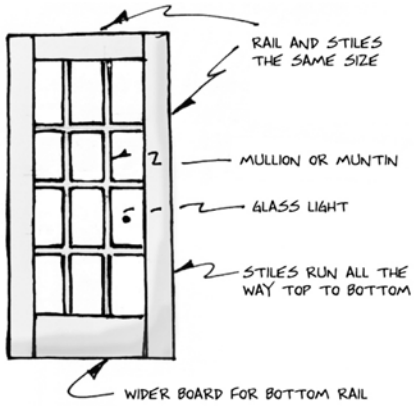
*DOOR A - OPENS ON AND DOWN. ACTOR ENTERING IS NOT SEEN UNTIL AFTER THE DOOR IS SHUT

*DOOR B - OPENS DOWN AND OFF

*DOOR C - OPENS OFF AND UP. ONLY ONE SIDE OF THE DOOR IS VISIBLE TO THE AUDIENCE. SOMEWHAT SELF-MASKING. ACTOR ENTRANCE IS STRONGER

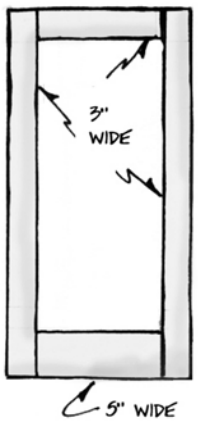
You may often find it necessary to make some kind of *French door*, which is really a window you can walk through. In fact, some people refer to these doors as French windows. French doors that open offstage show on only one side, and thus only one side of a real door will need to be reproduced. If it is possible to buy a "real" door, that is absolutely the best thing to do. Unfortunately, scenery designs often call for a door of a specific size that may not be commercially available, or a door with a unique size or style of windowpanes.

Another reason to include this method of door building is because it is another example of how to do laminated plywood construction. *Laminating* means to glue together a number of different layers in order to make an object that cannot easily be cut from one single piece. It has been discussed repeatedly throughout the book in such diverse structures as stressed-skin platforms and flat building. The method just covered of constructing door frames is another example of laminating.



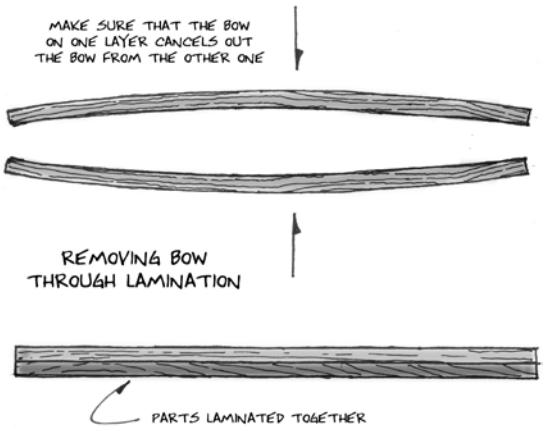
FRENCH DOOR CONCEPTS

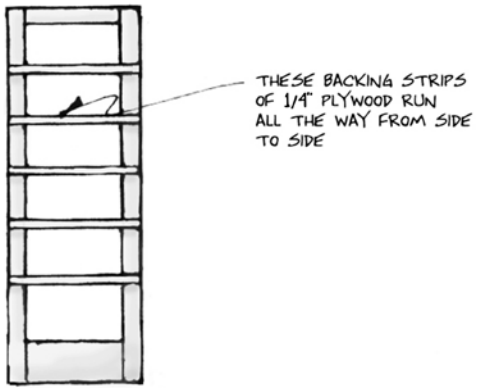
Start designing the structure of the door with a frame that defines the perimeter. The width of the stiles and rails is dependent upon the size of the door. A wide door can support the visual weight of broader stiles than a narrower door can. Double French doors will look better if you reduce the size of the two stiles that touch each other in the middle. The bottom rail of any door should be wider than the top rail.



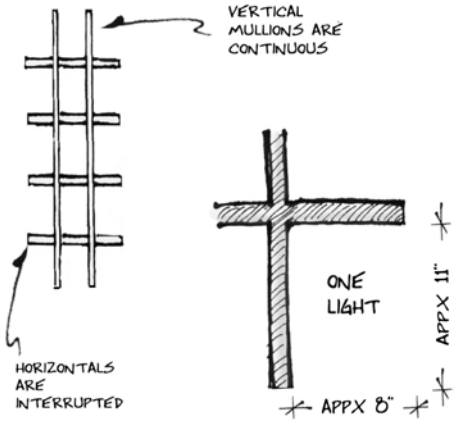
1/2" PLYWOOD PARTS

Begin by ripping down some ½″ plywood for the outer perimeter of the door. The best material to use is either ½″ lauan or cabinet-grade plywood. It is important to use some good stock for this project, as the door will need to stay flat and true on its own, with no help from the surrounding structure. Plywood of any type almost always has at least a small amount of bow to it. The door is made of two layers glued together, and it is important to alternate the bow so that the two layers are in opposition to one another. The finished product will be very flat and stable if you do, but it will be warped and unusable if you do not.





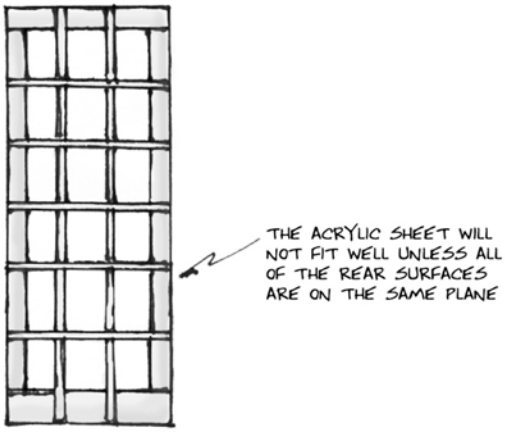
All of the window sections or *lights* should be the same size. Normally, these lights are taller than they are wide to give the door a slimmer, more elegant appearance. It is best to use a proportion in the neighborhood of 8″ wide by 11″ tall, but these measurements are intended for reference only. The exact amount should be determined by the size of your door.



The best way to connect the mullions is by again laminating two sections of plywood together. You might try ½″ ply for the front part, which sticks out into the door itself, and ¼″ ply for the backing strip that runs across the rear of the mullions and onto the side frame.

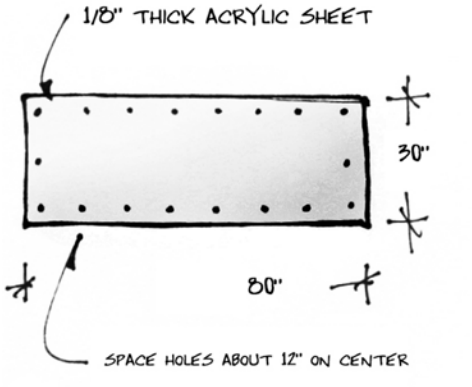
Be sure to stagger the joints of the ½″ ply mullions and the ½″ ply backing strips so the resulting lamination gives strength to the entire structure.

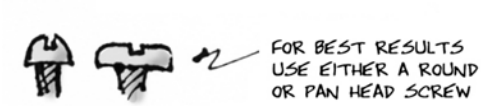
It is important to fill in all the voids so that the backside is flush all around. That will make the plastic cover fit better.

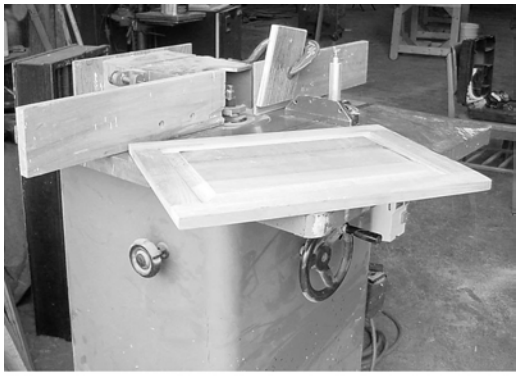


Acrylic sheet, also known as Plexiglas, can be cut and drilled with ordinary woodworking tools as long as you take care not to overstress the material. It can be quite brittle, especially when working with very thin sheets. Cut a sheet of ⅛″-thick acrylic to 30″ × 80″, the size of the outer dimensions of our door. Drill a ⅛″-diameter hole every foot or so around the outside edge of the plastic, about an inch in from the edge. Use these holes to screw the sheet into place. Be careful not to overtighten the screws, or the plastic will break.

"Real" doors of this sort are made using cutters on a *shaper*. A shaper is like a very large and stationary type of router, where the cutters are sticking up rather than down. Two sets of cutters are used to form positive and negative profiles. The cutters have been very precisely manufactured so that the wooden parts they cut will have a snug fit that is suitable to join with carpenter's glue. The slot on the side of the rails and stiles is meant to accommodate the panel that makes up the interior of the door.



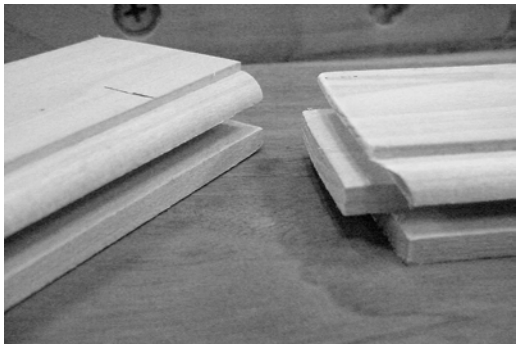




SHAPER AND RAISED PANEL DOOR

YOU CAN SEE A FINGER BOARD USED TO HOLD THE WORK FLAT TO THE TABLE, AND A SET OF CUTTER HEADS IN THE CENTER.

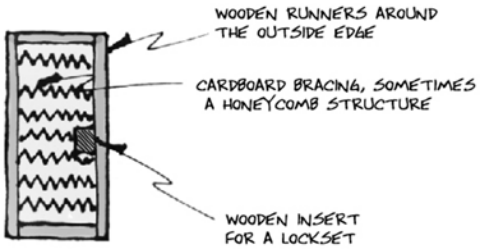
You can make a door by cutting the sides of the stiles so they have a positive profile, and the ends of the rails so that they have a negative profile. Most passage-type doors are somewhere between 1¼″ and 1¾″ thick, and you need to use cutters that will accommodate that thickness. They tend to be quite expensive, but you can use them many times. Cabinet door cutters like the ones shown here are much more common and are meant for stock that is about ¾″ thick. The smaller doors are much easier to construct.



Hollow-Core Doors

Hollow-core doors are engineered using the same principles as a stressed-skin platform. Two very thin panels are glued onto a lightweight framing that consists of small lumber or composite strips around the outside that provide hard points for attaching hardware and for keeping the profile rigid. The inside of the door is braced with corrugated cardboard bent into a zigzag pattern. This makes for an amazingly strong structure, considering that the outer skins are only ⅛″ or less thick.

Sometimes you may wish to alter a lauan hollow-core door into another shape, or to put a window in it, or make some other modification. Hollow-core doors are an excellent choice for this sort of thing, because they are lightweight and inexpensive. The hard part of making a flat and straight panel is already done for you. Such lightweight materials make it easy to cut the door to some other shape, but care must be taken to ensure that the edges of any modified area be resealed to preserve the rigidity of the structure.

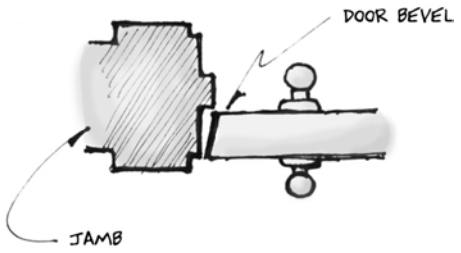


INTERIOR OF A HOLLOW-CORE DOOR

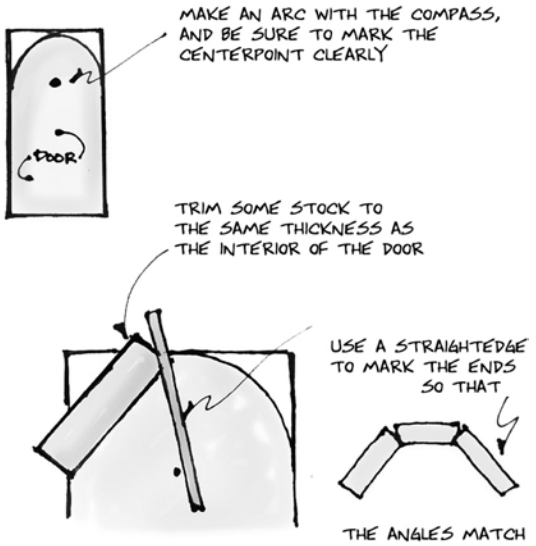
These doors are available in a wide range of sizes. Some are prehung in a jamb and are not suitable for our purposes. It is much better to get just the door slab. You can modify a hollow-core door for much less than it costs to make an equivalent structure yourself from scratch. It is a lot less trouble too, but remember that 6′-8″ is the tallest they come.

Changing the top of a hollow-core door is a common way of remaking one. For this example suppose that the design calls for the top of the door to have a rounded profile. Before cutting the door, check to see whether there is a marking for the top, and/or a marking for the bevel side. On some doors, the block of solid wood that makes it possible to install a lockset is of such a size and shape that the door can only be used one way. This type should have "top" marked on one end. The bevel edge is intended to hold the lockset, and the opposite edge is the hinge side. The bevel is provided to make the door close without striking the jamb. These

doors come in left-handed and right-handed versions, so you have a 50/50 chance of the bevel being correct. If necessary, you can run the door through the table saw to change the direction of the bevel and only lose about an eighth of an inch or so of material.



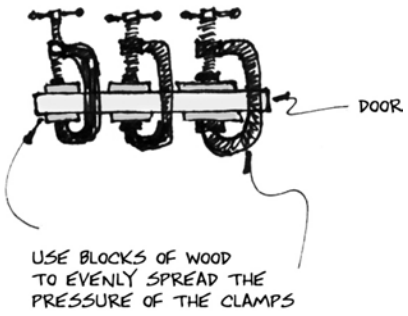
Use either a large bow compass or trammel points to lay out the circle that forms the top of the door. Use a jigsaw to cut away the unused portion of the top. Be aware that the surface of a lauan door is easily splintered, so take whatever precautions are available. The grain of the door runs up and down. If you cut from one side to the top, and then start over on the other side to the top, most of the tearout will occur on the scrap part of the door. Sometimes masking tape can be used to reduce tearout.



Note that the inside of the door is filled with cardboard spacers, and that some of them extend all the way to the edge you have just cut. Peel back the cardboard a bit to install the new edging. Use a sharp chisel or a utility knife. Don't peel away more than is necessary, because the cardboard is in large part what really holds the door together. The resulting space between skins will be somewhere in the neighborhood of $1\frac{1}{8}''$. Measure your door exactly and trim down a length of 2×4 so that it is the same thickness. The 2×4 on edge may be thicker than your saw can cut, so you may need to flip the two-by over and make a second pass to cut all the way through.

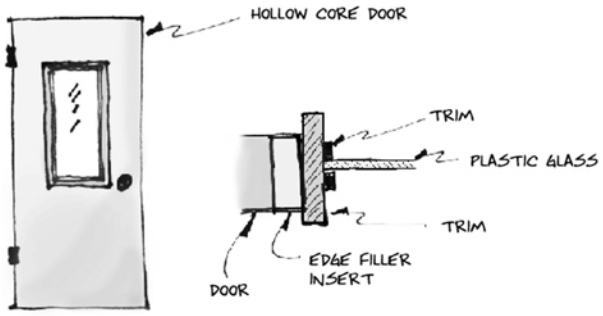
Lay the stock on top of the door. Use the center point to mark the ends of the boards so that they will fit together end to end. Depending on the radius of the curve, it may take several sections of wood to fill the void. You need only about an inch or so of material inside the door, and the rest will be hanging off outside it.

It is best to join these filler pieces to the door using only glue, because the lauan skins are so thin that any type of nail or screw or staple will do more harm than good. Use plenty of glue, and clamp the two sides together using some extra boards to spread out the holding power of the clamps. The boards will also keep the clamps from making round marks in the soft lauan skin.



Don't worry about cutting a curve on the filler boards until after the glue has set up. It is more important to get a good glue bond so that the door will stay together well. If you cut the curve first, it will be much harder to line everything up.

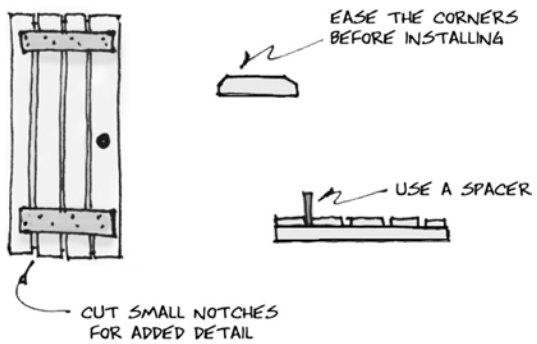
Another common modification to a lauan door is to make an insert, such as a window, in the center of the door. The process is much the same as with the top of the door, but this time you will need to put some glass in the hole. Cut out the center of the door, so that the hole is larger than the glass area needs to be. Fill in the edges with small strips of wood glued into place. These will need to be the same thickness as the inside of the door, and the process is much like that used for the curved top door, except that the pieces are straight instead of curved. You may want to put some trim around the hole to dress it up.



PUTTING AN INSERT IN A HOLLOW-CORE DOOR

Cut some small trim pieces to $\frac{3}{8}'' \times \frac{1}{2}''$ (or get some small quarter round) and use this as a stop to hold the window in place. Notice how the trims are sized to create a number of reveals that enhance the appearance of the window. (Of course, "glass" refers to acrylic sheet. Real glass on stage is quite dangerous!)

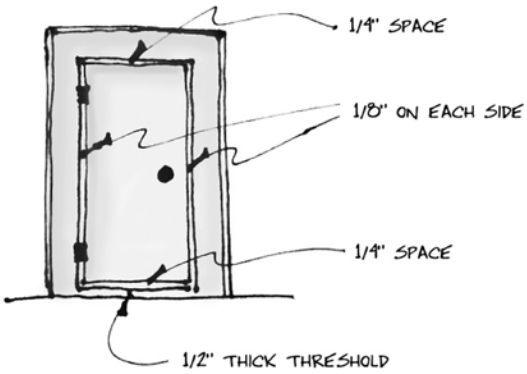
Occasionally, it is necessary to make a door look as though it is built of strips of wood, rather than one solid slab. This can easily be done by adding some strips to the front of a hollow-core door. It is tempting to simply use the table saw to plow some grooves into the surface of the door, but the veneer is too thin for that. Cut some strips of $\frac{1}{4}''$ lauan to the desired widths. Use a sander to ease the corners of these strips before they are put into place. Glue and staple them to the door using spacers made of an appropriately thick material. The spacers are a quick way to ensure uniformity when laying down the individual slats. Just be aware that the spacers tend to let the slats creep out of alignment after a while. Every so often (once or twice on something as narrow as a door), use a tape measure to check whether the slats are parallel to the side. Fudge them back into position if there is a problem. Remember that this process will make the door thicker than it was. It will therefore require more room in the jamb, and the door stop must be laid out accordingly.



These have been only a few of the possibilities of altering/making doors, but the methods shown here can be adapted to fit many more needs.

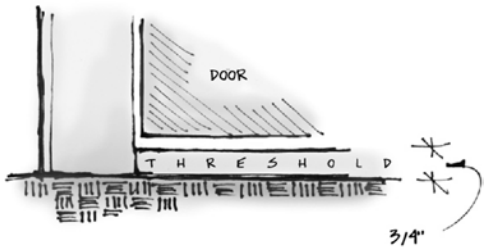
Hanging Doors

The process of attaching a door to a jamb is known as *hanging* the door. Whether it is a door that you have bought, made, or found on the street, the process of hanging a door is basically the same. The door must be checked for the proper size to fit into the jamb, hinges must be put on, and the lockset installed. The procedure must occur in that sequence in order to avoid repeating a step.



Any door you are hanging must be slightly smaller that the hole it will fit into. This would seem to be obvious, but the real question is how much smaller. The amount varies from one situation to another, but in general, stage doors do not need to fit as tightly as "real" doors do. The front door to your home must keep out rain and cold drafts, so a tight fit is mandatory. These factors are not usually a problem on the stage. It is much more important in the theatre that doors operate smoothly and dependably. If the door is too tight, it may swell from humidity and stick. Faux-finish painting tends to be quite thick, and may cause the door to bind. Keeping in mind that the door should have some extra play, I like to leave $\frac{1}{4}''$ space at the top, $\frac{1}{4}''$ from the threshold, and $\frac{1}{4}''$ from side to side. Thus, if the opening is $30'' \times 80\frac{1}{4}''$, the door slab should be $29\frac{3}{4}'' \times 79\frac{3}{4}''$, so trim it down accordingly. In a perfect world, the frame would have been constructed to exactly the right size, but in reality this rarely happens. The designer may often not find "just the right look" until long after the frame has been built. It is always good to use methods that are flexible enough to make reasonable changes. Of course, there is just no way to cut down a 36″-wide door to fit into a 30″-wide frame.

Remember that the bottom of the door is already spaced ½″ from the floor because of the thickness of the threshold. This means that the swinging door actually has ¾″ clearance from the stage floor, which is just about right. This will allow the door to pass over irregularities on the surface, and/or things like rugs that may not appear on the ground plan. Also, if the wall is not exactly plumb, you may have a problem with door clearance as it swings open wide. If the wall is tilted slightly toward the door side, this is almost sure to happen. Leaving extra clearance space is a good idea. The audience won't see it and it is good insurance.



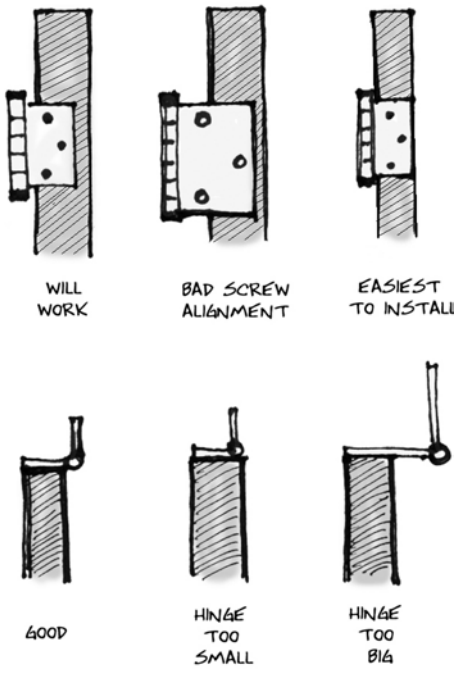
THE 3/4" SPACE WILL ALLOW THE DOOR TO SWING EASILY OVER OBSTRUCTIONS ON THE FLOOR WITHOUT GETTING JAMMED

As shown before, the side of the door that holds the *lockset* is traditionally beveled a few degrees to ease the process of closing the door. If you need to trim one side to make the door fit, that is generally the side to trim. If you must trim more than a quarter of an inch or so, you may need to consider what effect this will have on the solid wood inserts on the inside of the door that form the stable base for the lockset. Sometimes it is best to trim just a bit off both sides of the door. If the door is solid wood, the question is how much can be lost before the proportions get screwy. There are limits to how much may be removed without ruining the door. Any trimming of the vertical size is best done from the bottom where it is less noticeable. Remember to ease the corners just a bit with sandpaper once the trimming is done.

THE TOP OF THE DOOR IS OFTEN MARKED

IT IS BEST TO TRIM THE BEVELED EDGE. THE HINGE SIDE MAY BECOME TOO WEAK IF YOU TRIM IT MUCH. TRY TO MAINTAIN THE BEVEL IN THE CORRECT DIRECTION.

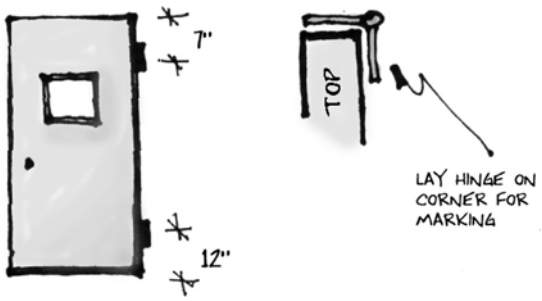
The next step is to install the hinges. Butt hinges need to be of a proper size for the thickness of the door. All of the barrel of the hinge must extend past the face of the door, or it will bind when operating. If the hinge is extremely oversized, it may cause the lockset side of the door to bind on the jamb when closing.



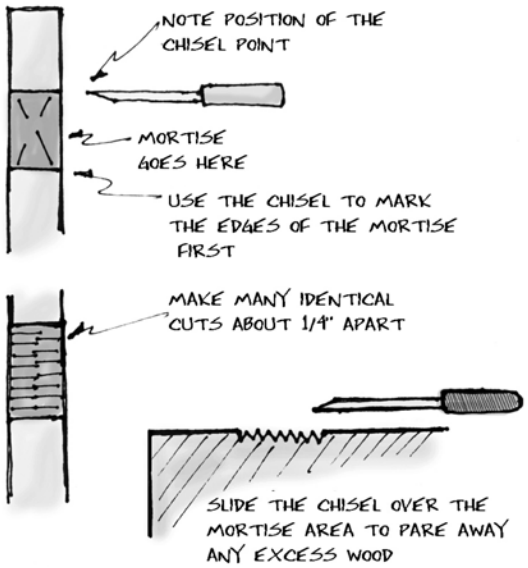
There is some leeway in mounting the hinges as to how far they extend onto the edge of the door. It is possible to install the hinge so that it is more to one side than the other, but care must be taken to ensure that the screw holes not get too close to the edge. All of the hinges must be of the same size and type, and must be mounted in the exact same way, or they will bind. *Binding* is indicated by creaking and groaning noises, and by an increasing difficulty in swinging the door. Binding will eventually cause the door to fail by causing the screws to pop out. Binding is a result of the hinge pins being out of alignment with one another, so that some part of the structure must warp out of shape when the door swings.

Most lightweight stage doors will work just fine with only two hinges. Sometimes, when an unusually heavy or peculiar door is required, it may be necessary to use three hinges. Study the door to determine which side of the door the barrels should be on (the side the door swings to), and which end will be the top of the door. Lay the door down so that the hinge edge is up in the air. It is customary to center the top hinge 7″ from the top and the bottom hinge 12″ from the bottom. Make the marks accordingly. It is fine just to

mark the center of the placement, as most hinges have a screw hole in the middle that can be used to align it. Open the hinge to a 90-degree angle and place it on the door edge, centered on the mark you just made. Snug the hinge up to the corner so that it is square with the edge. Mark the top and bottom of the hinge. Repeat the procedure on any other hinges.

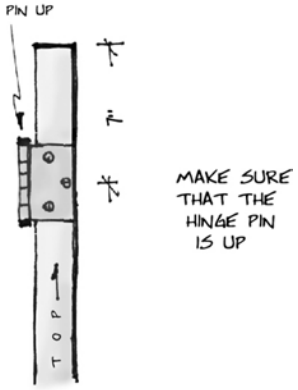


Use the marks you made as a guide in mortising the wood to accept the hinges. A *mortise* is a depression created in wood so that the face of the hardware will be flush with the surface. There are jigs that you can buy for your router that act as a guide in making the mortise, and if you have one, then follow the directions on the box. If not, you can make the mortise with a hammer and chisel. Mortising is not always necessary. It there is enough of a space between the door slab and the jamb, you can just attach the hinges without mortising.

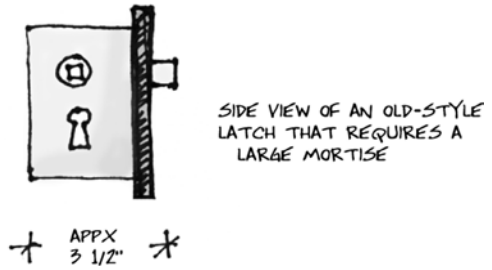


Using a *chisel* takes a bit of skill, and the chisel must be very sharp to work well. The flat side of the chisel should face away from the mortise. The bevel side is toward the mortise. Use the hammer to strike the chisel and cut in along the outside lines. That will keep the wood from chipping off where you don't want it to. Once the perimeter has been established, use the chisel to score the entire inside of the mortise area, every ¼″ or so. This scoring must be done at a right angle to the direction of the grain of the wood. Try to hit the chisel with the same amount of force on every blow so that it will cut into the wood the same amount each time. Notice that these actions result in some quasi-loose ¼″-wide chunks inside the mortise area. These can be removed by raking the area with the chisel. Use the chisel with the flat side down to pare away small slivers of wood. Do not use the hammer when the chisel is in the flat position, because there is too much danger of splitting the wood and/or removing too much material. Repeat the process until the mortise is smooth and clean. The hinge should fit in so that it is square, snug, and flush with the surface of the door edge.

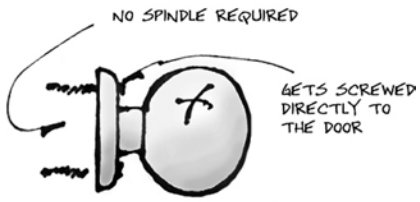
Once the mortises are complete, attach the hinges to the door. Use the screws that came with the hinge. Drill pilot holes if necessary. Attach the hinges so that they are top up, which means that the pins are removable going up. If the hinge is upside down, it is sometimes possible for the pin to slip out inadvertently.



You can install the lockset either before or after hanging the door in the frame. There are a number of different types of locksets, but only a couple of them are in common use today. Old-style sets required a huge square mortise in the edge of the door and are extremely difficult to install. If you are using an older salvage door with the lock already in it, there is no problem. If not, you might consider filling the mortise with wood and/or Bondo so that a modern lockset will work.



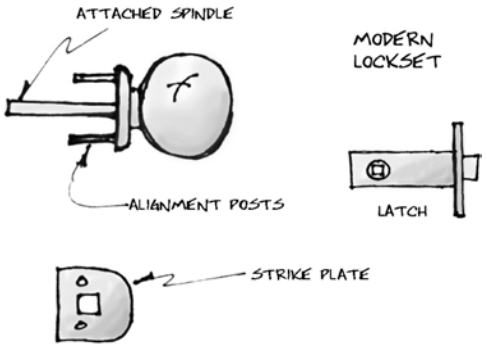
The two main divisions of locksets are those known as the locking type and the simpler passage type. Some *dummy* sets are sold for closet doors that are really just for show. Dummies consist of just the knob with no latch, and will not hold the door shut at all. The *latch* is the part of a lockset that clicks when you shut the door. It keeps the door from opening after it is shut. *Passage* knobs are intended for interior rooms where there is no need to restrict access by locking the door. Locking sets are those that include a lock. Passage knobs are the most useful in the theatre, as there is generally no need to lock any door on a set unless the action of the play specifically calls for it. Even then it is best not to really lock the door, because it may be difficult to unlock later on. Dummy knobs work well if some other catch is used to hold the door shut.



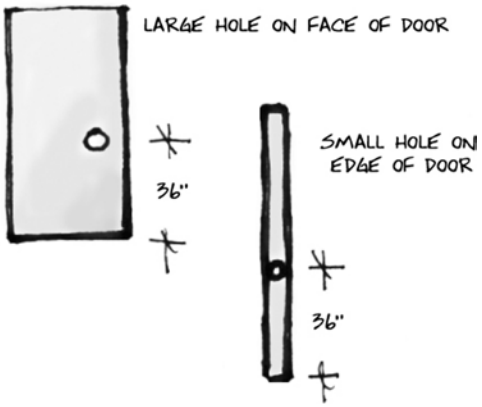
DUMMY KNOB

Newer locksets have three main parts: the knob with the spindle attached, the knob that the spindle fits into, and the latch. The *spindle* is a shaft that fits through the latch. The latch operates when the spindle rotates. The *strike plate* fits on the jamb and defines a hole for the latch to fit into. Note that the spindle is permanently attached to one of the knobs. In older locksets, the spindle is a separate part.

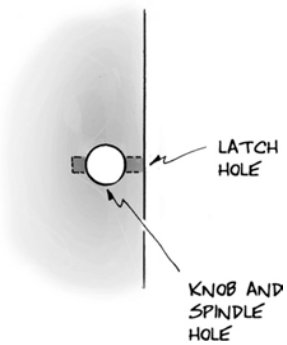
Installation of a new-style lockset is rather straightforward. If the set has just been purchased, then there should be some instructions in the package, and perhaps a template to mark the holes. Two holes will need to be drilled into the door, a large one on the face for the knob/spindle assembly, and a smaller one on the edge for the latch. These sizes vary a bit depending on the manufacturer, but the large hole will be somewhere in the neighborhood of $1\frac{3}{4}$″ to 2″ in size and the small one either $\frac{7}{8}$″ or 1″. The center of the knob, and



therefore the large hole, should be 36″ from the bottom of the door, or for a panel door, centered on the toggle closest to that amount.

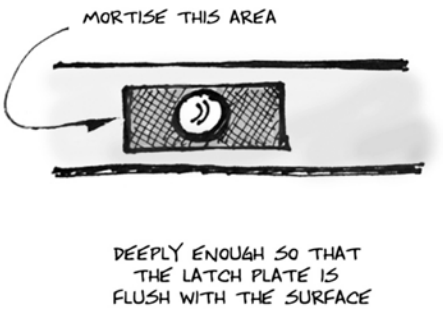


A new lockset will have a template in the package that shows how far to mark the hole from the edge of the door. If the template is missing, measure the latch from the outside part to the center of the spindle hole. This is the distance in from the edge of the door to the center of the large hole. This hole should be drilled all the way through the door slab and is too large for anything but a hole saw. Cut through one side far enough for the pilot bit to poke through the other. Turn the door over and center the hole saw on the pilot hole. Then drill the second side. This will prevent tearout on the backside of the door from drilling all the way through.



The $\frac{7}{8}$″ latch hole is centered the same measurement from the bottom of the door, and it should also be centered front to back on the edge. This hole should be drilled all the way through to the large hole, and sometimes it is necessary to drill past the large hole when the latch needs to extend farther into the door. To determine the depth of the $\frac{7}{8}$″ hole, hold the latch up to the door and see what is required.

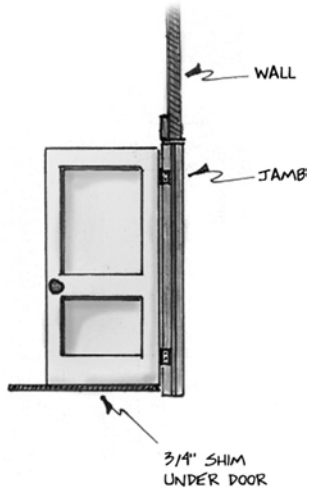
Once these holes have been drilled, a mortise must be created in the door edge so that the latch plate will fit flush to the edge of the door. If the latch plate is not mortised into the door, it will catch on the jamb when the door is shut. Feed the latch into the door as far as it will go, and square it up with the edges. Mark around the perimeter of the plate and remove the latch. The mortise can be made with a chisel in the same way that the hinge mortises were made. Slide the latch back into place and secure it with the two screws provided.

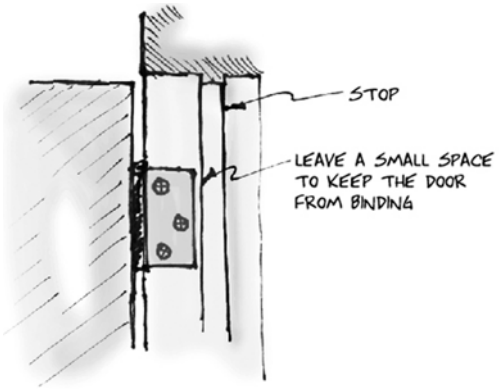


Make sure that the latch is pointing in the right direction for it to work. The bevel side should be on the side of the door that fits into the frame. Feed the knob with the spindle through the latch. There are most likely two screw posts on the knob that line up with holes in the latch. It should be intuitive how the other knob fits on and how the screws are used to connect the two knobs. A screwdriver at an angle will usually fit well enough to tighten the screws, but sometimes an offset screwdriver is required.

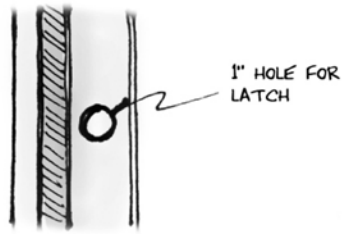
The door is now ready to be fitted into the jamb. Lay a $\frac{3}{4}$″ thick shim on the floor at a right angle to the hinge side of the opening. Set the door in place with the hinges in a position to be screwed onto the jamb. The shim will automatically adjust the height of the door in the frame, but it is important that the entire assembly be plumb, or the shim will not work properly, and the centering will be off.

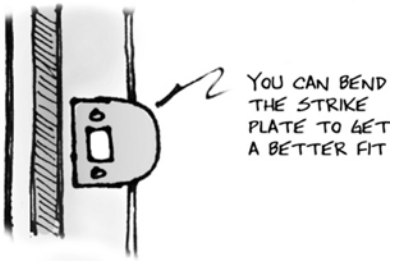
When screwing the hinges in place, make sure that there is about a small gap between the face of the door and the door stop. If the door is hung too far into the jamb, it will hit the stop and not close properly. Put only one screw in each hinge, and shut the door to see if it fits well. If it does not close properly, take note of where it is binding, and fix the problem. If there is a good fit, finish putting in the rest of the screws.

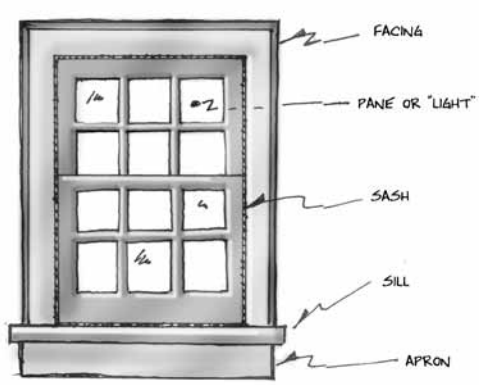




The final step is to install the strike plate. Close the door and mark the center of the latch. This should be 36″ from the bottom, of course, but it is easier and more accurate to mark the placement from the latch. With the vertical placement taken care of, measure the thickness of the door, and divide the amount by 2. This is the distance of the center of the strike plate hole from the edge of the door stop. Drill a 1″-diameter hole about $\frac{1}{2}$″ deep on this mark. Put the strike plate into position, and screw it down. There is a bit of trial and error involved in finding the correct front-to-back placement for the strike plate. Opening and closing the door a few times after the hole has been drilled will make it easier to judge the exact placement.



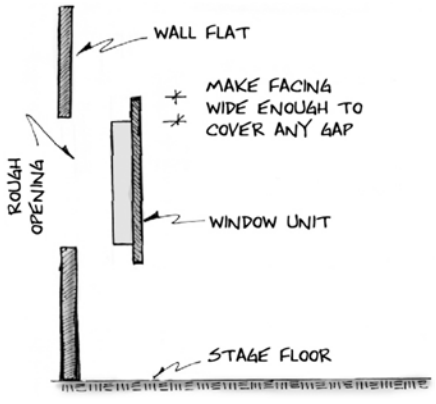




PARTS OF A WINDOW

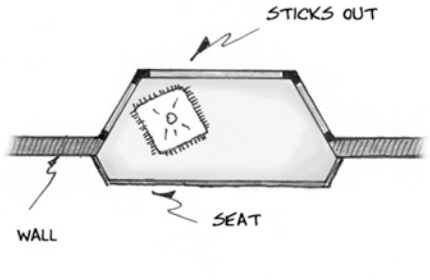
Windows

Window techniques are very similar to those used in the construction of doors. The basic idea is to put together a frame that will fit into a rough opening in a wall made of flats. The rough opening should be enough larger than the insert so that the window will fit in easily. The facing trim is quite a bit larger than the part of the window that fits through the opening, so you can have considerable space between the opening and the window itself. If the space is too small, however, you won't be able to get the window to fit in the opening.

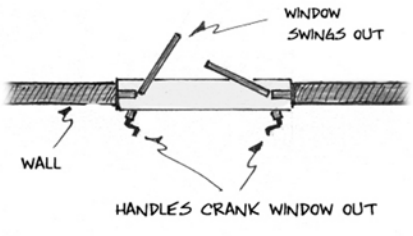


Window jambs are made in the same way as door jambs, but as the facings do not normally extend all the way to the floor, an apron is placed across the bottom of the unit. The differences are mainly cosmetic, with the structural methods of joining the parts together remaining the same.

The movable portion of a window is called the *sash*, and each window pane or section of glass is known as a *light*. The bottom part of the window where you could rest an object is the *sill*. Trim that fits on the wall under the sill is the *apron*. Windows having two sashes, one hung over the other rigged to slide up and down, are called *double-hung windows* and are the most popular type. A window that cranks outward when a handle is turned is a *casement window*. A series of three or more windows that project out the side of a wall is a *bay window*.

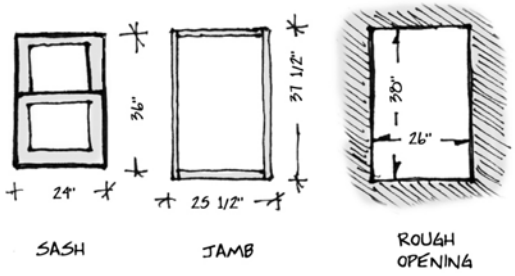


PLAN VIEW OF A
BAY WINDOW AND SEAT

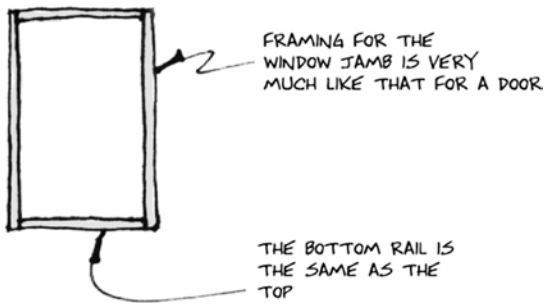


PLAN VIEW OF A
CASEMENT WINDOW

The inserted window unit can be only as big as will fit through the rough opening. Like every other building project, it is important to develop a cut list of the parts used in constructing the unit. The method of sizing the parts goes like this:

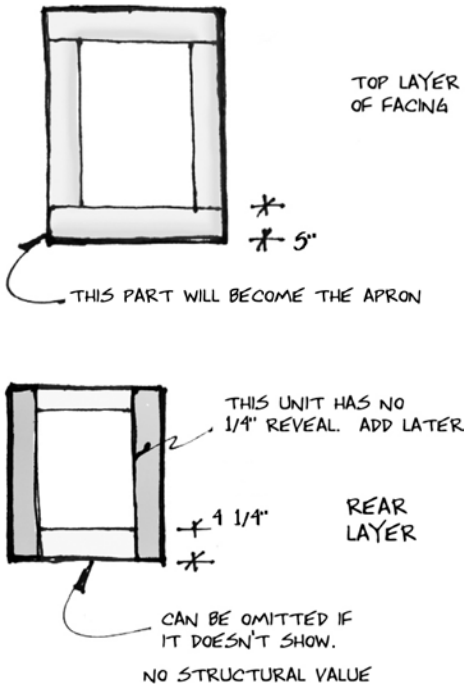


The next step is to build the jamb, and this is done in the same way as a door jamb. The width of the material used is somewhat dependent upon the style of window and the method of constructing it. A sash that must actually move up and down will require an extra amount of room to fit in all of the working parts. As in door construction, the stiles run all the way from top to bottom, and the two rails fit inside.

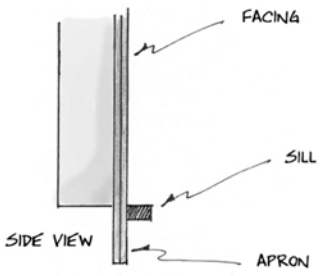


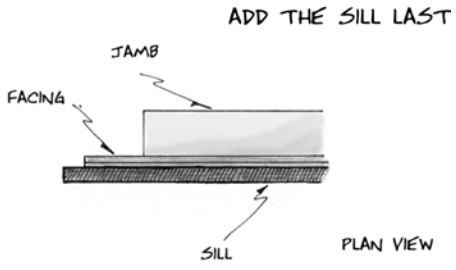
The width of the stock used to create the facing is dependent upon the design of the trim, but for our purposes say that the facing itself will be 5″ wide. Normally, the window trim should match the door trim. As you will recall, the door trim had a ¼″ reveal between the jamb and the facing so that the barrel of the hinge had a place to go. You don't necessarily need that part on a window, because it doesn't have hinges.

The rear piece of plywood for the facing must be ripped narrower than the front section to allow for the space taken up by the jamb. In this case, as there is no reveal, the ½″ plywood should be 4¼″ wide. Naturally, you should arrange the corner so that the two layers of plywood overlap one another and give the joint a great deal of strength.

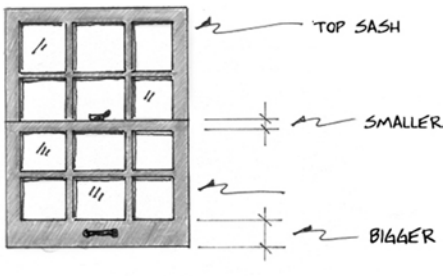


In an old-style real-world window, the sill, or stool, was put in first. The facing trim around the window and the apron were attached last so that water would not get into the house. But for our theatre window, it makes more sense to create a strong box shape first and add the sill later. The sill is formed by cutting a strip of white pine that protrudes outward from the facing about 1¼″. Glue and nail the sill in place. Finish trimming the face frame with whatever trim style is appropriate to your design.



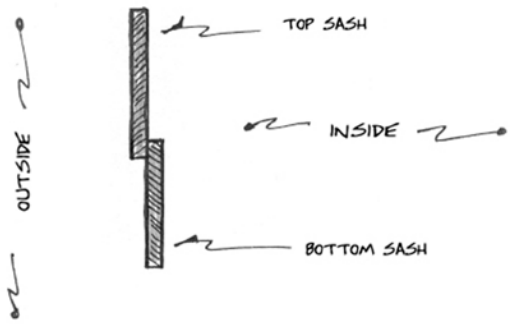


Building the sash can be the most difficult part of the job, and certainly the most time-consuming. It can be done in the same way as the French door shown earlier, using slats and backing pieces; an easier method is to use a solid section of plywood and cut out the lights. Lay out the sash so that it is the right size, bearing in mind that the outside edge of the frame will need to be larger in scale than the mullions are. Also, the bottom rail of the lower sash is generally sized a bit more generously to allow for a handle to be installed.



BOTTOM SASH IS TOWARD THE INSIDE OF THE ROOM

The bottom rail of the top sash is intended to line up with the top rail of the bottom sash, which allows for the installation of a sash lock. The bottom sash fits toward the inside of the room and passes on that side of the top sash.



Drill a $\frac{3}{8}$″ hole inside every light and use a jigsaw to cut out each individual opening. If you must make a large number of sashes, you might consider making a pattern and to use it in conjunction with a router to make a number of multiples. The advantage is that all of the parts will be exactly alike, but this also means that great care must be taken to make a pattern that is straight and true. You can use this same technique on other construction projects that require many multiples of a complex shape like grills and other wrought iron work.

The type of router bit for this technique is called a *flush-trim pattern bit*. It differs from a standard flush trim bit in that the roller bearing is on the top of the cutter rather than on the bottom. This allows the pattern to be secured on the top of the piece being cut out. The router is then run around the profile with the roller bearing running along the edge of the pattern. The cutter extends through the piece being cut and trims it off to the exact size and shape of the pattern.