Building your own kitchen cabinets allows you to create the kitchen of your dreams, without having to pay for high-priced custom cabinets. New cabinets can also significantly add to the value of your home. The author's kitchen, shown here, has cherry cabinets built in a traditional style, with frame-and-panel doors, and has the modern convenience of solid-surface synthetic countertops.

Designing and Building Kitchen Cabinets

An overview from subfloor to soffit

by Frank Klausz

When my wife and I decided to buy our new house, I promised her right away that I would remodel the kitchen. Our old house had a bright, airy kitchen, and although the house we bought was only 10 years old, its kitchen was small and dark. It is hard to say which was worse: the commercially made dark-walnut-stained oak cabinets or the cheap-looking plastic-laminate countertops with particleboard that had swelled wherever it had gotten wet. We started by ripping out the old cabinets and tearing down a couple of walls to open the space. Then it was up to me to build a new set of kitchen cabinets.

Although I've been a professional cabinetmaker and furnituremaker for more than 25 years, it still took me a considerable amount of time to build the cabinets and to attend to all the details necessary in completing my new kitchen (shown in the photo above). But no matter how formidable the notion of building an entire kitchen worth of cabinets may seem, it can be a manageable undertaking if you invest a little time in carefully planning the layout, design and construction of the cabinets. While this article isn't going to tell you everything about kitchen cabinets, it will present an overview of what you'll need to know before you design and build them. In the next few pages, I'll tell you how I went about making, finishing and installing the cabi-

nets for my own kitchen, but first I'll give you some hints on laying out your kitchen cabinets and appliances.

Designing a kitchen—When you consider all its built-in features, the kitchen is, by far, the most complicated room in the house to design. Whether you hire an architect to do it or you tackle the job yourself, here are a few of the more important considerations. Begin by locating the three most-used elements in a kitchen: the sink, stove and refrigerator. It's best to situate these so that they form a triangle with a perimeter not exceeding 18 ft. The oven and refrigerator shouldn't be directly adjacent (to keep cold things and hot tilings separate), and there should be a hood above the stove or cook top. Plan to have a counter near the oven so that you have a place to put a hot pan. A peninsula in my kitchen provides that convenience, plus it separates the kitchen from the adjacent dining area. The dishwasher should be located next to or near the sink and below the dish cabinet, so that loading and unloading dishware is expedited. If your floor plan allows it, locate the sink below a window, and install a light above the sink.

Having enough places to put things is an issue in a kitchen, and you should involve everyone who will use this room when designing the number and location of drawers, cupboards, pullouts, spice racks, bins, etc. For instance, my wife wanted a spice rack near the cook top so she could readily add seasonings while cooking; so I built a rack on the back of an upper cabinet door adjacent to the stove.

A variety of shelves and pullouts makes best use of a cabinet's interior space. I prefer adjustable shelves to fixed ones because they allow you to change shelf spacing to accommodate different-size items. Storage for bulky things, like pots and pans, can be cumbersome; in my kitchen, I built two big pull-out drawers in the cabinet under the stove, plus built a large drawer under the oven. 1 used several other types of pullouts for better access to stored goods: a large rack in my pantry cabinet (to the left of the oven) holds cans, bottles and small boxes; two racks under the sink hold cleaning supplies and a garbage bag (see the photo above). I also made good use of the corner where two lower cabinets meet—space usually lost because of difficult access-by employing a half carousel, slide-out lazy Susan, which holds bulky kitchen accessories like colanders and graters. The pullouts I used are made by Amerock (Box 7018, Rockford, Ill. 61125-7018; 815-963-9631), but dozens of other pullouts, racks and bins are available from a kitchen-hardware supplier.

You should choose all the major appliances for your kitchen, as well as the sink, before you design your cabinets. There arc no standard measurements for kitchen components: each major appliance will come with a specification and installation guide that gives dimensions for rough openings in cabinets and locations of electrical outlets, plumbing, ventilation ducts, etc. It's essential that you follow the manufacturers' guidelines to the letter, otherwise you're likely to run into trouble later. When I made the cabinet for my refrigerator, I fudged the placement of an electrical box by only ½ in. and yet the unit wouldn't fit properly. You may also wish to buy all your countertop and under-cabinet-mounted appliances, such as coffee makers, blenders, etc., before designing. This way you can adjust spacing between cabinets and size cabinet features, such' as appliance garages, accordingly. Also you should have spec sheets for any special hardware for such things as lazy Susans, pull-out trays or bins, or electrical fixtures, so your cabinets will accommodate them.

Cabinet design- I like the look of more traditional cabinets with frame-and-raised-panel construction. However, I also wanted my kitchen to be modern and practical, and so I installed Corian solid-surface synthetic countertops, which I custom fabricated to suit my kitchen (see the sidebar on p. 59).

There are dozens of different pull-out bins, racks, lazy Susans and other hardware available to help you organize cabinet storage and make good use of difficult-to-access spaces. For his under-the-sink cabinet, the author chose a slide-out lazy Susan, a pull-out rack for cleaning supplies and a wire holder for the garbage bag.

If you buy production-made cabinets, what you get are off-the-shelf-size boxes that are configured to fit your kitchen. In a custom kitchen, you can make cabinets to the exact sizes you want and configure them in a way best suited to your needs. Using a standard 4-ft. by 8-ft. sheet of plywood as a sizing limit, you can build individual cabinets up to 8 ft. long and join them in any way you like to make longer counters, peninsulas or islands (single lower cabinets not joined to a wall). Just make sure you check the size of the doorway through which you'll be bringing cabinets into the room or you may end up tearing a cabinet apart to get it into your kitchen.

Standard dimensions for cabinets once again take the 4-ft. by 8-ft. plywood sheet into account: Lower cabinets are 24 in. deep and uppers are 12¼ in. deep (including the face frame), so that the width of a sheet has maximum yield. Standard lower-cabinet height is 36 in. to the finished top, which means the cabinet itself is somewhat shorter, depending on the thickness of the countertop used. Upper cabinets typically start 18 in. above countertops (24 in. above stove tops) and extend either to the ceiling or, as in my kitchen, to a soffit. I like soffits because they prevent upper cabinet shelves from being too far above reach for practical use.

When deciding on the arrangement of doors and drawers, any lower cabinet between 2 ft. and 4 ft. wide should have two doors; wider cabinets should have four doors all the same width or one pair of double doors and one single door, not necessarily the same width as the doubles. To provide lots of storage for silverware and utensils, lower cabinets should have a 4-in.-deep drawer above the doors wherever possible. Some people like at least one bank of drawers that increase in depth from top to bottom. To keep the look of the lower cabinets consistent, false drawer fronts are fitted wherever drawers can't be, like under the sink or stove top. For drawer guides, I use model AL1500 full-extension metal guides made by Alfit America Inc. (Box 38159, Richmond, Va. 23231; 804-222-0705), which have a white baked-on finish and an L-shaped lip on the part that screws to the drawer to support it from underneath. Although more expensive than regular guides, I prefer full-extension guides because they provide access to the entire contents of a drawer.

Irregular or leftover spaces give you a chance to be a little inventive. The microwave oven I installed under the upper cabinet just left of the sink was about 4 in. narrower than the space, and so I simply fitted one side of the cabinet with a 4-in.-wide stile. If you have a space more than 6 in. wide, you can add a small vertical

Klausz made good use of a high, narrow area next to the refrigerator by building in a small phone desk, with a pencil drawer below it and a bookshelf above it. The sides of the floor-to-ceiling cabinets on either side of the doorway to the dining room are done in the same frame-and-panel style as the kitchen doors.

compartment, with or without a door, for storing trays and baking sheets. On the wall of my kitchen opposite the sink, I had only a 26-in space to the right of the refrigerator and decided the kitchen could use a telephone desk. So I built a cherry desktop with a pencil drawer, some open shelves for the phone book, cookbooks, etc., and a high cabinet above the shelves (see the photo above).

Story-stick measurement and layout-The first step in actually building your kitchen is to accurately measure the interior spaces the cabinets will occupy. This is especially important if you're building floor-to-ceiling cabinets, upper cabinets that must fit a soffit or lower cabinets to fit between two walls. Scribes on cabinet face frames and carcases (discussed later) allow a bit of fudging, but the best way to take and keep accurate measurements in your kitchen is to use a "story stick" (also called a story pole). A story stick is made from any 2-in.- or 3-in.-wide scrap of plywood that's as long as your biggest cabinet dimension. On one side of the stick, draw the cabinet and face-frame measurements that run horizontally, and on the other side, draw the cabinet and face-frame measurements that run vertically. You then use these references for marking and cutting out all your cabinet parts: stiles, rails, cabinet sides, etc. (see the left photo on the facing page). The stick can be used to set the fence on the tablesaw or set the slop on a radial-arm or cut-off saw.

Why a story stick instead of a cutting list? There are several good reasons. First, this method makes it almost impossible to make a cutting mistake because you're referring to a full-size pattern instead of a number. Also, using a story stick allows you to make cabinet parts in any order: you can make the doors and drawers before the cabinet as long as the parts correspond to the story stick. And more than one person can work on the cabinets (one can make the face frames, another the carcases, etc.) and all the parts will fit together.

Cabinet construction—Building kitchen cabinets isn't really much different than building any cabinet with a carcase, face frame and back. I made all my carcase parts-bottoms, dividers (also called bulkheads), rough tops and interior ends—from ¾-in.-thick hardwood plywood (either veneer core or lumbercore) and used ¼-in.-thick plywood for the cabinet backs. I prefer A-2 cabinet-grade plywood, with good hardwood face veneers on both sides; however, many people prefer Kortron, melamine or one of the other prefinished particleboards, because these sheet goods are relatively inexpensive and they are easy to clean.

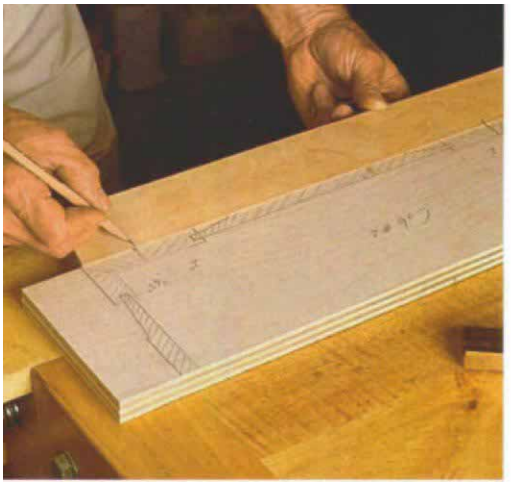
Each lower cabinet is a box-like carcase that sits atop a low plinth-style base (see figure 1 on p. 58). The 4-in.-high base supports the cabinet and provides a 2¼-in.-deep toe space, acting as a kick plate at the front of the cabinet. This separate base makes it much easier to level the lower cabinets, as I'll describe later. The carcase's exterior sides have a ½-in.-deep rabbet on the back edge, which receives the back and allows the cabinet to be scribed to the wall (see the center photo on the facing page). The corners of the carcase have tongue-and-groove joints and dividers in simple dadoes. On lower cabinets, it's best to arrange the dividers so that one side is flush with one edge of a stile. This allows the drawer guide on that side to be screwed to the divider directly and to be flush with the stile; a plywood shim brings the guide flush to the stile on the other side. Upper cabinets are built just like the lower carcases, only they have a 3-in.-wide mounting strip along the inside at the top back edge. This strip provides strength when the cabinet is screwed to the wall.

Once the cabinet carcases were done, I made and attached the face frames, which keep the cabinets from racking and provide a strong place to attach the door hinges. I made all my face frames from solid ¾ cherry and planed them to ⅞ in. thick. I ripped most of the stiles and rails to 2 in. wide, except the rails under the drawer, which I ripped to 1½ in. wide. To speed up making the frames, I used biscuits to join most frame members. Since the #20 biscuits I used are longer than the frame is wide, I cut the slots off center (see the photo at right on the facing page). The part of the biscuit that protrudes is trimmed off after the frame is glued up; on lowers, this area is either covered up by the countertop or is on the underside of the frame, and so it doesn't show. On upper cabinets where a hidden joint is needed, I used ¼-in.-dia. by 2-in.-long dowels. Once all the frames were assembled and trimmed, I glued them to the carcases and used #10 biscuits for strength and for help when aligning the plywood carcase edges. Face frames on end cabinets that will meet a wall or an adjacent cabinet should overhang the carcase so you can scribe them later.

I detailed my upper cabinets by covering the bottom surfaces with "chrome" plastic laminate (Formica brand), and 1 contact-cemented this on before assembling the cabinets. The chrome plastic laminate serves a double purpose. First, it's durable enough to withstand steam, moisture and heat, which tend to ruin most wood finishes. Second, the mirrored surface reflects light, making the areas under the upper cabinets less dark. To add a dramatic effect, I tacked two rows of low-voltage light strips (available from Vista Manufacturing, 52864 Lillian Ave., Elkhart, Ind. 46514; 219-264-0711) to the bottom of each upper, locating them just behind the bottom rail.

Doors and drawers—To give my kitchen a smooth, clean look, I chose to mount the doors flush with the face frames. This meant that the doors had to be made more accurately than overlay-style doors, where any error simply overhangs the face frame. However, sizing flush doors is simple using the story-stick method described earlier. I used traditional frame-and-panel construction, with mortised-and-tenoned frames fitted with raised panels. Door frames may be doweled or splined, but since I have a wonderful old hollow-chisel mortising machine in my shop, I can cut mortises very fast; I make through mortises and cut the tenons with a jig on the tablesaw, wedging them in place. For raised panels, which are put in place when the doors are assembled, a groove is cut on the inner edge of the frame with a dado blade on the tablesaw. When making raised panels, I try to select stock with similar color and figure and to orient the figure the same way on adjacent panels; this is a minor detail, but important for good appearance. To give the doors and finished ends a little accent, I chamfer the inner edges of the frame with a 45° chamfer bit in a router. The chamfer stops about 2 in. from each inside corner.

Once the doors were assembled and the through tenons were



A story stick makes cutting cabinet parts practically foolproof: There are no numbers to forget or add up incorrectly. Here, Klausz transfers marks for cutting door rails to length; the other side of the stick has all the cabinets vertical measurements.

Tongue-and-groove joints for comers and dadoes for dividers are a simple and strong means of mating plywood carcase parts. A rabbet on the back edge of the sides provides a housingfor the cabinet back and allows the cabinet to be scribed to the wall.

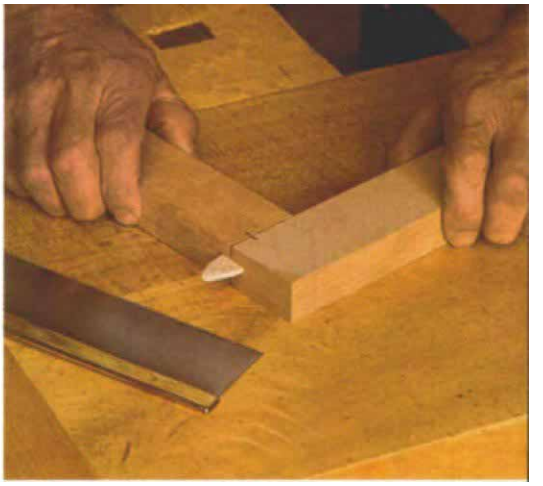


Plate-joinery biscuits used on some face-frame corner joints speed up construction. The slot is made off center because the biscuit is too wide to be completely hidden by the rail; it is trimmed afterward and can't be seen when the kitchen is complete.

wedged and planed flush, it took only a small amount of trimming to get each door to fit its opening evenly all the way around. While there are many styles of hinges that work with a flush-fitting door, I chose 2½-in. brass butt hinges because I like their traditional look. If you use butt hinges, be sure to get the kind with removable pins; they make hanging and unhanging the doors much easier. Installing butt hinges is time-consuming, since they must be mortised into both the frame and door, but using a hinge template and a guide-base-fitted router speeds up the process.

To cover up the plywood, I edged the top of each drawer side with a thin band of maple. My drawer front is a piece of ¾ solid cherry, which is screwed to the front of the plywood drawer. I built my drawer sides from ½-in.-thick white-maple plywood, joined by rabbets in all four corners, and cut the bottoms from ¼-in.-thick plywood. The 8½-in.-wide drawer located under the oven, designed to hold baking pans, was built the same as the other drawers, except its drawer front was done with frame-and-panel construction. With the Alfit drawer guides I used (as well as with most metal drawer guides), all drawers had to measure ¼ in. less deep and 1 in. narrower than their face-frame openings.

Finishing—After all the cabinets received their final sanding with 220-grit paper, I fit and trimmed all drawer fronts so they had slightly less than a 1/16-in. gap all around. I prefer to finish my cabinets, inside and out, before I install them and then to touch up any dings or mars afterward. So first I sprayed all the interior cabinet surfaces, shelves and drawers (not the drawer faces) with two coats of sealer and followed this with two coats of nitrocellulose lacquer, waxed to a silky smooth finish. I then rubbed the cabinet exterior with a natural oil finish: I applied four coats of Waterlox oil and then a final coat of a mixture of about 25% marine varnish and 75% Waterlox oil. A lot of people prefer to use a more durable finish, such as lacquer or polyurethane, but if my oil finish is properly maintained and treated with paste wax twice a year, it keeps its beauty for decades. It's my belief that nothing makes natural wood look more beautiful than a hand-rubbed oil finish.

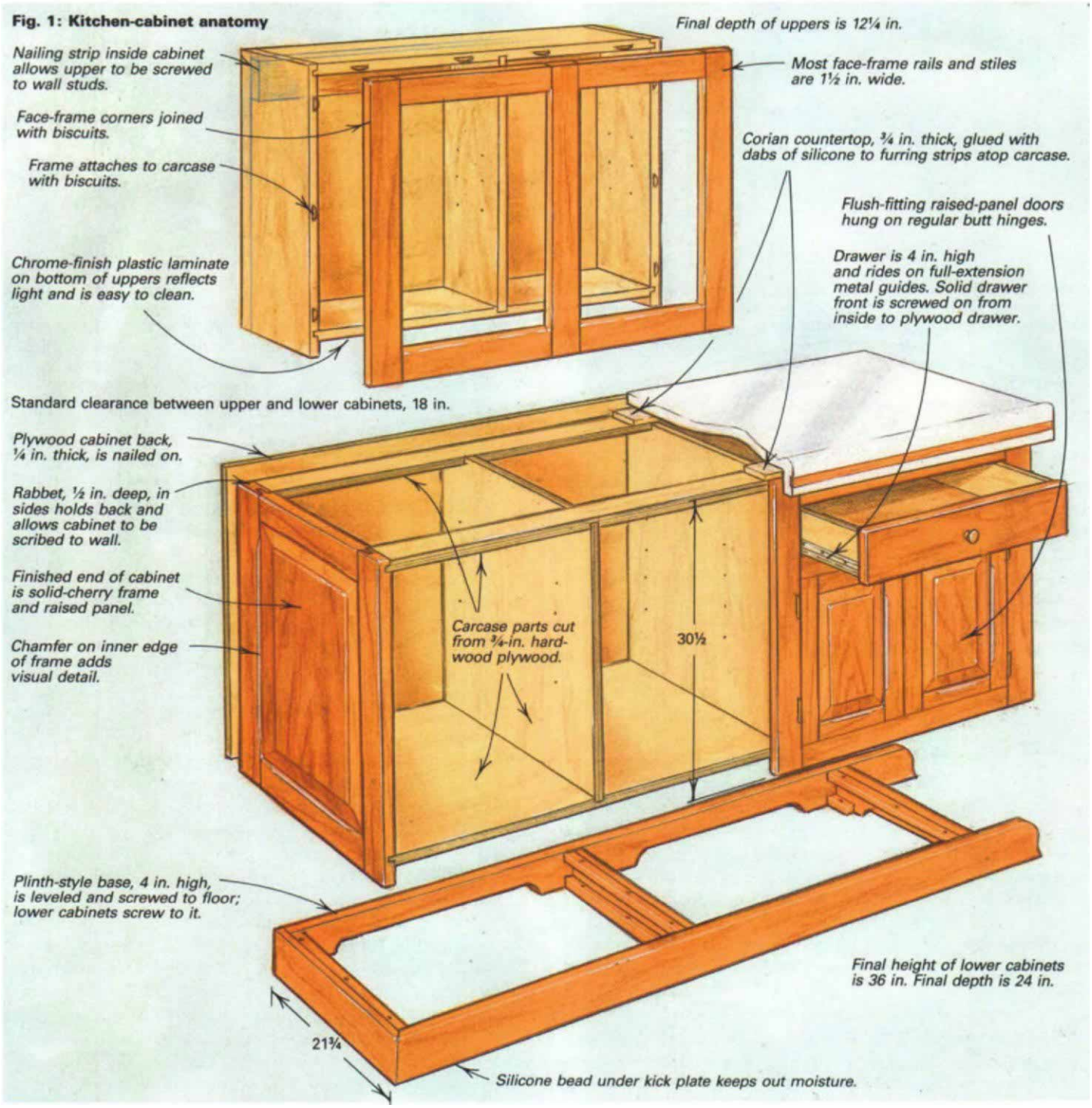
After finishing, I screwed all the butt hinges and magnetic door catches to the face frames and then hung the doors to make sure they would open and close without rubbing. Next, I screwed the metal drawer guides to the cabinets and inserted all the pullouts and drawers to make sure they would operate smoothly. Each drawer front was then aligned and attached to its respective drawer with four countersunk screws from inside. Finally, I removed all the doors (by pulling the removable hinge pins), drawers and pullouts and replaced them after the cabinets were installed. If your kitchen has a lazy Susan, be sure to mount its hardware *before* installing the cabinets; if you forget, it's a very tedious job at best.

Installing the cabinets—Before the cabinets are put in place, all the necessary electrical wiring and plumbing should be done. This includes lighting circuits, lights recessed into the soffit, under-cabinet lights, and all outlets and switches. Wiring for the range hood, stove top and oven(s) should be roughed in and duct work for the hood should be installed. Finally, water and gas pipes, such as for the stove, sink and refrigerator (if it has an ice maker), should be roughed in at the point where they enter or pass through cabinets.

The best time to install cabinets depends partially on the type of floor the kitchen will have. A linoleum or hardwood floor should be laid prior to cabinet installation and it should go from wall to wall so that leveling cabinets is easier. Expensive tile floors can be laid and grouted after the cabinets are in place, to save on materials. In either case, try to finish all painting and wallpapering prior to cabinet installation, and touch up any damage later.

The first installation task is to level all the lower-cabinet bases. Using a 4-ft. level, I started with the base of the most central lower cabinet and worked toward the end cabinets, planing material off the kick plates and feet on each base and/or adding wedges and shims as necessary. Although you may have to fuss with this, taking the time here makes the rest of the installation much easier and ensures that all drawers and pullouts will be level and door hinges will be plumb, allowing smooth operation. If the floor is very irregular, you may need to conform the kick plate by scribing and planing its lower edge. When the bases are level in every direction, screw them to the floor through the thin strips glued to the base members (see figure 1), first laying down a bead of silicone along the lower edge of the kick plate to prevent floor-washing water from seeping in and deteriorating the finish and wood. (If the floor is tile, add this bead after the tiles are grouted.) The lower cabinets can now be scribed to the walls and screwed to their bases. Adjacent cabinets are screwed together through the ends, and corner cabinets, which connect at 90° or at an angle, have butted face frames scribed and screwed together. Most dishwashers require an open space between cabinets, save the rough top and a single top stile between the face frames of adjacent cabinets.

I hung the upper cabinets next, trimming the scribe strip at the back edge of each cabinet to level it and to make it fit snugly



against the wall. Instead of holding the upper cabinet to the wall for scribing, which is an awkward job at best, I held my level to the wall, noted the amount of variance from plumb (say ⅛ in. out at the bottom) and then handplaned the scribe strip accordingly. If the wall is very irregular, hold a scrap of ¼-in.-thick plywood plumb and to the wall, scribe a pencil mark on it, and then transfer this mark to the cabinet. When the planing is complete, attach the uppers to the walls with 3-in.-long drywall screws driven through the mounting strips and into the wall studs. After hanging all the uppers, I fitted the board that will receive the overhead light between the cabinets on either side of the sink. Then I nailed on the valance strip, which is a piece of cherry with a decoratively scroll-sawn lower edge, and nailed ¾-in.-thick by ¾-in.-wide molding, mitered at the corners, around the top of each upper. This covers any seam between the soffit and tops of the upper cabinets. Finally, the countertop and built-in appliances were installed, leaving my wife and I only one thing left to do: cook up a big pot of Hungarian goulash to christen our new kitchen. □

Frank Klausz makes furniture and repairs antiques at his shop in Pluckemin, N.J. For more information on traditional kitchen cabinets and cabinet joinery, see Building Your Own Kitchen Cabinets *by Jere Gary, or* Making Mortise-and-Tenon Joints, *a video by Klausz. Both are available from The Taunton Press, 63 S. Main St, Box 5506, Newtown, Conn. 06470-5506.*

Drawings: Aaron Azevedo

Building a Corian countertop

Despite the traditional-style cabinets I built for my new kitchen, I made my countertops from a modern alternative to wood, tile and even plastic laminates. I built them out of Corian, a synthetic or "solid-surface" material made by Du Pont that's very popular in kitchens and bathrooms.

Solid-surface materials have many advantages over conventional countertops: They are durable, waterproof, and heat and scratch resistant. Further, they're easy to cut or shape with carbide blades or cutters, they can be sanded, and using a special glue that's the color of the material, you can mate pieces together without noticeable gluelines. And since the color goes all the way through the material, you can repair the surface by scraping or sanding out burns, dings and scratches. Corian is only one of several solid-surface counter materials, such as Surell and Avonite, and it comes in a variety of colors and thicknesses. (For solid-surface materials, look under "countertops" or "kitchen cabinets" in your local yellow pages.)

I chose ¾-in.-thick white Corian and used matching 2-in. edging that gets glued on and then shaped with the router for a non-drip lip. I started by carefully measuring the cabinet tops: I had to make a U-shaped top to fit around my kitchen. I cut the sheet of Corian to length and width on the tablesaw, using a triple-chip carbide-tooth blade. Cutting Corian is quite messy: the white shavings make it look like it's snowing. After cleaning up the sawmarks with a sharp, low-angle block plane (you may find it easier to do this with a hand-held power plane or with a flush-trim bit in the router), I trial-fit the joints dry and left the top in three pieces. They will be glued together during installation.

I cut the edging and glued it on the perimeters of the counters, leaving ¼ in. above the surface for the lip. You must glue the edging with special two-part joint adhesive (colored to match the Corian) and mix it following the instructions on the package. It is important to clean the joints well with denatured alcohol before gluing. Also, remove all dirt and pencil marks: Anything left on the faces of the joints will show through the translucent Corian. Although the glue has gap-filling abilities, the tighter the joint is, the less visible the glueline will be. Apply the glue in a single pass and with an even motion, just as if you're caulking a seam. Take care because repeated passes can cause voids or air bubbles. Now pull the joint together, clamping the pieces the same way you would clamp a wooden panel, and let the excess glue set up without cleaning.

I wanted nice rounded corners on the ends of my peninsula (see the photo on p. 54), and when my supplier told me I couldn't have both a non-drip edge and rounded corners, I decided to fabricate my own. Once the corner pieces were glued together, as shown in figure 2 below, I shaped the corner with a router, using a flush-trim bit against a template, and then I sanded it smooth. A special router bit, available from Fred M. Velepec Co., Inc. (call 800-365-6636 for your local dealer), shapes the lip on the corner and the edge around the countertop. I held the router horizontally, with the guide bearing on top of the counter, and worked it carefully around the corner; then I cleaned up the shaped edge with sandpaper. To visually tie in the countertop with the cabinets, I inlaid the edging with a strip of ¼-in.-wide cherry, glued with silicone into a groove made with a kerf-cutting bit in the router.

Next, I marked the exact location of the sink and stove top with a template, and cut out the openings with a plunge router and a single-flute straight bit guided by a template. I left ½ in. extra around the opening of the undermount sink for trimming later. Whenever you cut this solid-surface material, be sure you round the corners; sharp corners invite cracking.

With the lower cabinets leveled and screwed in place (see the main article), I tacked two narrow strips of plywood at the front and back edges of the rough top. Corian should never be installed over a solid underlayment because heat may accumulate and cause cracking. Then I glued the first section of counter to the strips with dabs of silicone about every 10 in., and I left a 1/16-in. clearance between the Corian and back splash because Corian expands and contracts just like wood. You don't have to clamp down the Corian; its own weight is enough. At the same time the counter is being siliconed to the cabinets, each of the other counter sections must be glued together with the joint adhesive to form a continuous counter. This can be hectic, since the setting time of the silicone is only about 15 minutes, but it's necessary since a large countertop shouldn't be moved after the sections are glued together. Do not clean the excess adhesive until it sets; then plane the joint area flat and sand it smooth.

Top-mounted appliances, like the stove top, can now be siliconed in place, with all mounting screws run into wood blocks glued to the Corian (screwing directly into Corian may cause cracking). When gluing the undermount sink in place, apply enough adhesive to squeeze out all around. After it cured, I trimmed and shaped the sink cutout with a ¾-in.-dia. roundover bit in the router, which yields a nice soft edge. For final cleanup, I smoothed all rough areas with an orbital sander, starting with 220-grit paper and finishing with 320-grit. For a back splash, I chose ceramic tile and caulked the gap between the countertop and tile with a bead of silicone. —*F.K*

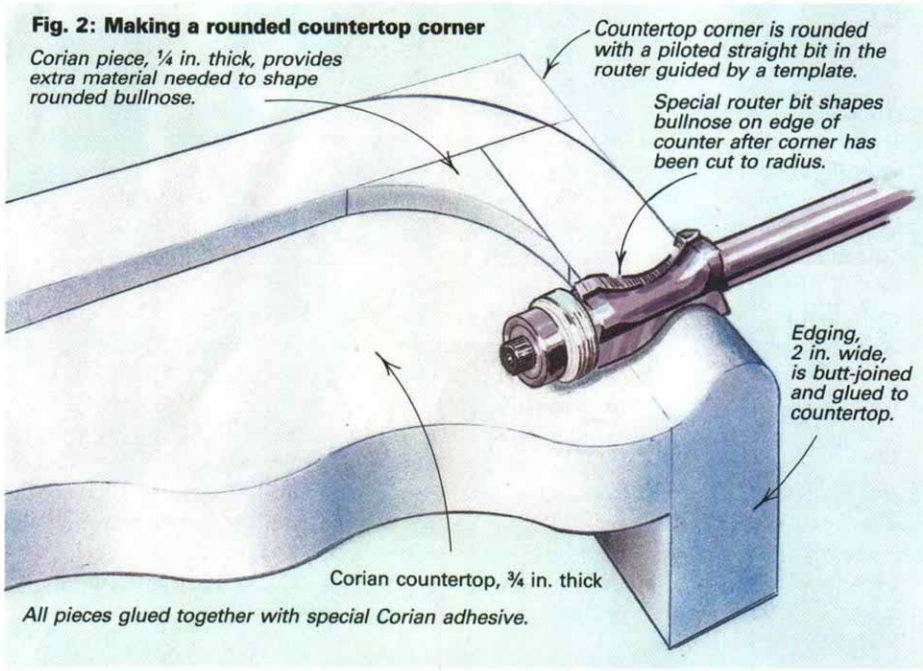


Fig. 2: Making a rounded countertop corner