

Bookshelf Basics

A guide to support systems, shelving designs and materials

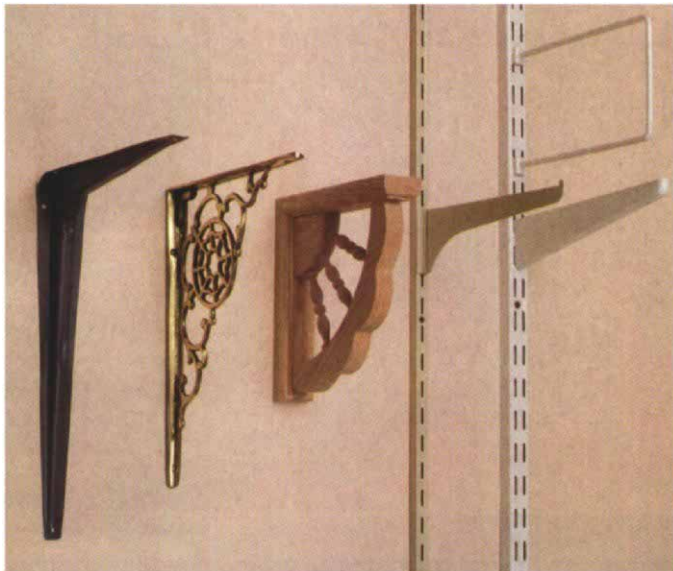
by Bruce Greenlaw

It's hard to define the quintessential bookshelf. The one above my writing desk, for example—a plastic-laminated particleboard shelf supported by three inexpensive metal wall brackets—was quick to build and perfectly suits my needs. The fixed shelf puts my reference books within arm's reach of my chair, and foam-padded steel bookends that I got at Wal-Mart keep them from falling off. Thos. Moser Cabinetmakers' furniture-grade cherry bookcases (Thos. Moser Cabinetmakers, P. O. Box 1237, Auburn, Maine 04211; 800-862-1973) (photo above), on the other hand, are designed to be heirlooms.

Bookshelves can transform a room into a library. Open shelves provide plenty of easily accessible room for books and collectibles. Glass-panel and raised-panel doors provide more secure shelf space, and related supplies can be stored in lockable drawers.

Between these two extremes lie a wide variety of shelving options. Basically, though, bookshelves are either housed in bookcases or supported by wall brackets (unless they're propped on milk crates or cinder blocks), and they're either fixed or adjustable. To my mind, the best shelving systems complement their surroundings and don't droop when they're loaded with books.

This article contains food for thought on designing bookshelves, plus an appraisal of shelving materials and hardware (sidebar p. 101). Of course, this information can be applied to virtually any type of shelving.



Bookshelves can be quickly and easily installed on wall brackets. Fixed brackets are screwed directly to the wall; adjustable brackets mount on slotted standards and can be moved up or down.

Measure the books, and size the shelves—Standard paperback books are about 4 in. wide (from the spine to the outside edge), but my binders, portfolios and biggest reference books are about 11 in. wide. Unless shelves will be used for storing old LP records (which are 12¼ in. wide) or giant art books, you'll rarely need to make bookshelves that are more than 11 in. deep. Some shops make 8-in. to 10-in. deep shelves and let wide books overhang.

If a series of shelves will be fixed in a bookcase or on nonadjustable wall brackets, measure the heights of the books that will be stored on them and space the shelves accordingly. Books range in height from about 6¾ in. tall for standard paperbacks to well over 12 in. tall, but most are in the 8 in. to 12 in. range. Don't forget to add ¾ in. to 1 in. of clearance above the books to allow fingers to grip them.

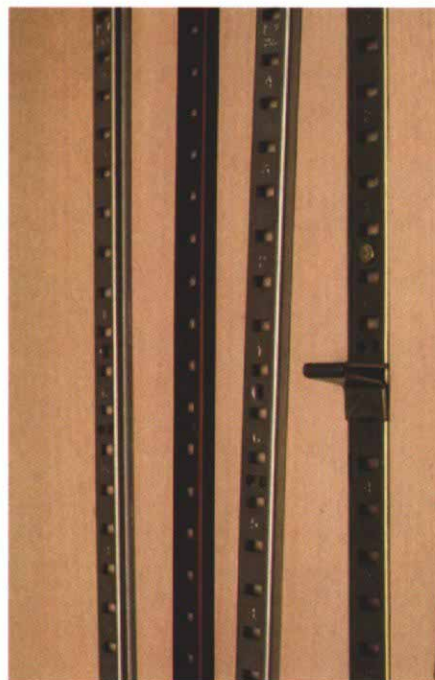
Shelf standards and hole-mounted clips make bookcases adjustable—Unless they're required for structural integrity, fixed shelves are probably unnecessary in bookcases. Adjustable shelves take much of the worry out of planning, offer more long-term flexibility and often result in more shelves fitting into a given space. The joinery for a bookcase without fixed shelves is simplified because you're basically just building a big box. Also, the supporting hardware for adjustable shelves is relatively inexpensive and easy to install.

Most shops don't use run-of-the-mill metal shelf standards to support exposed shelving. But metal standards are stronger than most alternatives, and I think they look okay if their color complements the surrounding bookcase. The standards are screwed or nailed in pairs to bookcase sides. They can be mounted on the surface, but most also can be recessed into dados for a more refined look (bottom photo). Barbed plastic standards that are simply pressed into dados (no nails or screws are required) also are available. But I've heard that these standards can be difficult to align, resulting in wobbly shelves.

Shelf pins are generally regarded as a step up from shelf standards (photo to top right). These pins are strong enough for most applications, and they're less conspicuous than shelf standards. Shelf pins typically have ¼-in. dia. shanks that fit into holes of the same diameter. The holes are



Shelf pins are inconspicuous. Shelf pins are less visible than shelf standards. Top to bottom: wire clip, which hides inside a groove at the end of a shelf; spring-loaded locking clip that prevents shelves from sliding or tipping; plastic clip; cushioned metal L-support; ornamental solid-brass pin; zinc-plated steel paddle; "library" pin with sleeve.



Metal standards are strong but conspicuous. Although metal shelf standards come with various disguising finishes, they tend to be more visible than hole-mounted shelf supports. Most standards can be recessed (at right) to make a finished appearance and to minimize gaps at shelf ends, or they can be surface-mounted.

spaced about 1 in. to 2½ in. o.c., and they're positioned so that shelves overhang the pins about 1 in. to 2 in. front and back.

Drilling shelf-pin holes can be tedious work, but a drilling template makes the job easier. A simple one can be made from a piece of tempered pegboard, which has ¼-in. dia. holes spaced 1 in. o.c. (top photo, p. 100). Using a drill bit with a drill stop mounted on it speeds the work and prevents the bit from boring through the workpiece.

Pegboard jigs don't last long, though. Commercial jigs are a better choice for production work. The acrylic shelf jig sold by The Woodworkers' Store (bottom photo, p. 100) has oversize holes that guide a self-centering ¼-in. Vix bit (or a 5mm Vix bit for metric work). The jig is only 19 in. long, but it

Templates simplify boring of shelf-pin holes. Drilling jigs make it easy to bore shelf-pin holes in parallel rows in bookcase sides. This disposable shop-made jig is tempered-hardboard pegboard, which has $\frac{1}{8}$ -in. dia. holes spaced 1 in. o.c.



Commercial hole-drilling jigs are durable. The acrylic jig shown here (sold by The Woodworkers' Store; see sidebar, facing page) has oversize holes that guide a self-centering Vix bit. A shelf pin is used as an indexing pin to extend the range of the jig.



can be indexed with a shelf pin to bore any number of holes accurately. The jig costs \$16, but the Vix bit adds another \$35. Another shelf-drilling jig is made by Veritas tools and is available through mail-order outlets (Veritas Tools, 12 E. River St., Ogdensburg, N. Y. 13669; 800-667-2986).

Woodworking and hardware suppliers sell a variety of shelf pins and supports (photo top right, p. 99). Trussed plastic shelf pins are the least expensive and the most obtrusive. Metal L-supports are stronger and more subtle than plastic pins. Padded L-supports cushion glass shelves and help protect fragile finishes. Locking pins made of plastic or metal help prevent shelves from sliding and tipping. They allow bookcases to be shipped with shelves installed, and they help anchor shelves in earthquake country.

To my eye, the best-looking shelf supports on the market are spoon-shaped pins made of nickel or brass. Several shops I know of bore oversize holes and tap special metal sleeves into the holes to support these pins. The sleeves help prevent the holes from deforming, and they lend an air of refinement to unused holes. Dave Sanders & Company, Woodworker's Supply and others sell matching spoons and sleeves. Shelf pins can also be hand-carved, cut from dowels or even fashioned out of brass brazing rods. For invisible shelf support, wire clips are the best choice. They're inserted

into holes bored into the sides of bookcases, and they hide inside sawkerfs cut into the ends of shelves.

Wall-mounted shelf brackets can be fixed or adjustable—Truth is, most of the bookshelves I've put up sit on plain metal wall brackets. The brackets install quickly with hollow-wall anchors or by screwing them directly to studs. Deluxe shelf brackets that install just as easily also are available. Two examples are the brass brackets sold by Renovator's Supply and the oak gingerbread brackets sold by The Woodworkers' Store (photo top left, p. 99).

For adjustable wall support, most hardware stores sell single-slotted metal standards that screw to walls and carry flimsy metal brackets that hook into the slots. But heavier-duty, twin-slotted systems (which have two rows of slots and hooks instead of one) are also available. The system sold by The Woodworkers' Store includes special screws that prevent shelves from sliding off the brackets and bookends that clip to the standards.

Dave Sanders & Company has the best selection of wall-mounted standards and brackets I know of. One type is mounted to studs before dry-wall so that only a slim slot is visible afterward.

Well-designed shelves don't sag—Most cabinet shops use simple rules of thumb to determine shelf spans. Generally (when ¾-in. thick stock is used to support heavy reference books), particleboard and medium-density fiberboard (MDF) shelves span up to about 20 in.; softwood and plywood shelves span up to about 34 in.; and hardwood shelves span about 36 in. Shelves that carry paperbacks will span significantly farther.

For more predictable control over shelf sag, some shops use the shelf-deflection table published in Architectural Woodwork Quality Standards (available for \$50, or \$5 for members, from the Architectural Woodwork Institute, 13924 Braddock Road, Suite 100, Centreville, Va. 22020; 703-222-1100). The table lists the uniform loads that cause various unfixed 8-in. and 12-in. wide shelving materials to deflect ¼ in. when spanning 30 in., 36 in., 42 in. and 48 in.

AWI's chart points out a number of ways to beef up shelves to increase spans or to support unusually heavy loads. For instance, gluing a ½-in. thick edgeband to a ¾-in. thick particleboard shelf increases the shelf's load-bearing capacity by about 15%. Veneering the particleboard on two faces and one edge with ⅝₁₀₀-in. thick plastic laminate increases its capacity by about 200%. Gluing a 1x2 solid-wood apron to the front edge boosts it by a whopping 300% to 400% (photo right). Greg Heuer, AWI's director of member services, notes that applying an apron to the back of a shelf, even pointing up (so that it hides behind books), gives the same results as a front apron. Although most people would consider a shelf deflection of ¼ in. to be excessive, halving the values listed in the chart would produce a less noticeable deflection of ⅛ in.

Several other strategies can be used for increasing shelf spans or load-bearing capacities. The most obvious is to use thicker shelves. Shelves made of 2x lumber, or two layers of ¾-in. plywood, for example, will span at least 48 in. Applying a half-round molding to the front edge of layered plywood creates a solid bullnose shelf.

For a significant span, consider building a torsion-box shelf, which works somewhat like a box beam or hollow-core door. These shelves consist of a grid of wood or plywood strips glued between two plywood skins. The biggest torsion-box shelf that I've heard of is 4 in. thick and 27 ft. long. Fixed shelves in bookcases can be reinforced by putting a back on the



Aprons stiffen the shelves. Putting a solid-wood apron on a shelf increases its load-carrying capacity. The sagging top shelf is ¾-in. particleboard. The virtually straight bottom shelf is ¾-in. particleboard with a 1x2 apron glued to the front edge.

case and fastening the back to the shelves, or by fastening intermediate support posts to the front edges. Adjustable bookcase shelves can be reinforced at the back with shelf standards and brackets or with hole-mounted shelf pins.

If you doubt the ability of a proposed shelf to support a given load, prop a sample shelf on a pair of blocks, load it with the weight it will carry and check the sag.

Recessing and trim make shelving look built in—Louis Mackall, owner of Breakfast Woodworks Inc. in Guilford, Connecticut, tells me that the best way to integrate shelving into a room is to recess it at least partway into a wall (top photo, p. 102), even if this procedure requires furring out the wall. According to Mackall, recessed shelves not only look better than

Sources for bookshelf hardware

Here's a short list of some useful companies to know about if you're in the market for bookshelf hardware.—*B. G.*

Dave Sanders & Company Inc.
107 Bowery, New York, N. Y. 10002
(212) 334-9898

Sells an impressive assortment of shelf standards, brackets and shelf pins, including Magic Wire concealed shelf supports and shelf pins with matching sleeves that reinforce pinholes.

Knappe & Vogt Manufacturing Company
2700 Oak Industrial Drive NE, Grand Rapids, Mich. 49505-6083
(800) 253-1561

Makes cabinet and shelving hardware, including twin-slotted, wall-mounted standards and brackets, shelf pins and heavy-

duty metal wall brackets that support up to 1,000 lb. per pair.

Rangine Corporation
P. O. Box 128, Millis, Mass. 02054
(800) 826-6006
Makes storage systems, including the Rakks Shelving System: extruded-aluminum, wall-mounted shelf standards with locking, infinitely adjustable aluminum brackets.

Renovator's Supply
P. O. Box 2515, Dept. 9898, Conway, N. H.
03818-2515
(800) 659-0203
Sells ornamental brass shelf brackets.

Woodcraft Supply
P. O. Box 1686, Parkersburg, W. Va. 26102
(800) 225-1153

Sells assorted shelf pins, including solid-brass pins and brass sleeves that reinforce pinholes.

The Woodworkers' Store
4365 Willow Drive, Medina, Minn. 53470
(800) 279-4441

Sells a range of knockdown fasteners, standards, brackets and pins; the best assortment of edgeband I know of; and tools and accessories.

Woodworker's Supply Inc.
1108 N. Glenn Road, Casper, Wyo. 82601
(800) 645-9292
Sells assorted standards, brackets, shelf pins, and tools and supplies.



Recessed shelving doesn't intrude. Breakfast Woodworks in Guilford, Connecticut, recesses shelving to blend it with the architecture and to create the illusion of space.



Bracket-mounted bookshelves can look built in. Philadelphia woodworker Jack Larimore applies fancy aprons to basic wall-mounted bookshelves to produce ornate library storage that is available for a modest price.

projecting shelves, but they also appear to add space. Projecting shelves appear to subtract space. Continuing a room's base and crown moldings (if there are any) around a bookcase also helps to unite the bookcase visually with the room.

San Francisco woodworker Scott Wynn considers horizontal details in a room when sizing built-ins. If window head casings are a prominent feature, for instance, he'll make the built-ins the same height as the head casings. Wynn also makes bookcases supported by deeper base cabinets. The cabinet tops serve as oversize shelves that support art books. Wynn cautions that bookcase partitions must be placed directly over cabinet partitions or the shelves will sag.

Except for furniture-grade pieces such as Thos. Moser's, most bookcases are boxes with routed edges or applied trim. The boxes can have butt joints held together with nails or screws in concealed locations, or with biscuits or plugged screws in exposed locations (for more on biscuit joinery, see *FHB* #70, pp. 50-53). Special knockdown fasteners can also be used, allowing units to be dismantled and reassembled. Tall bookcases should have 1/4-in. hardboard or plywood rabbeted into and tacked to the back for stability, a 1x nailer at the top for attachment to walls, or both.

Bookshelves don't have to nest in bookcases to look good. Philadelphia woodworker Jack Larimore has designed and built economical wall-mounted shelving that looks like pricey built-in furniture (photo left). The shelves are supported by metal shelf standards, but they're dressed up with decorative aprons. Ornamental metal and wood brackets can also be used to enhance the appearance of wall-mounted shelving (left photo, p. 99).

CHOOSING THE RIGHT MATERIALS

Solid wood is beautiful but unstable—Thos. Moser builds most of its bookcases out of $\frac{3}{4}$ -in. thick American black cherry. At the other extreme, I've used low-cost #3 knotty pine for a number of shelving jobs because it's relatively strong and inexpensive. Unlike some shelving materials, solid wood doesn't require edgeband, and edges can be detailed easily with a router or a hand plane.

Unfortunately, solid wood is unstable. It shrinks as it dries, and it expands and contracts across the grain in response to changes in humidity. It also tends to warp and cup more than sheet stock, causing adjustable shelves to seesaw.

One nifty idea I've seen is to use bullnose hardwood stair-tread stock for shelves. It usually comes in red or white oak, it's often glued up out of narrow strips for dimensional stability, and it's a sturdy 1 in. to $1\frac{1}{16}$ in. thick. Millworks and many lumberyards sell it, and when you factor in presanded finish and ready-made edge treatment, the price is reasonable.

Hardwood plywood is an industry favorite—Most shops I spoke with shun solid wood in favor of sheet stock such as hardwood plywood, particleboard or MDF (bottom photo). Sheet stock is more stable than solid wood, and it normally can be turned into shelving parts faster because it doesn't have to be flattened and straightened as solid wood often does.

Hardwood plywood is available with a veneer core, an MDF core, a particleboard core or a lumber core. Veneer-core plywood is strong, has excellent dimensional stability, holds screws well and is widely available (especially in birch, red oak and lauan). But it can have voids in the core that could occasionally cause a hole-mounted shelf pin to sag or to fall out.

MDF-core and particleboard-core plywood don't have voids, but they also don't hold screws as well as veneer-core plywoods do, although using particleboard screws (which have a deep, coarse thread) helps. These panels are also heavy, weighing almost 100 lb. per $\frac{3}{4}$ -in. thick sheet. This weight not only makes them awkward to machine, but it also makes them a questionable choice for portable bookcases.

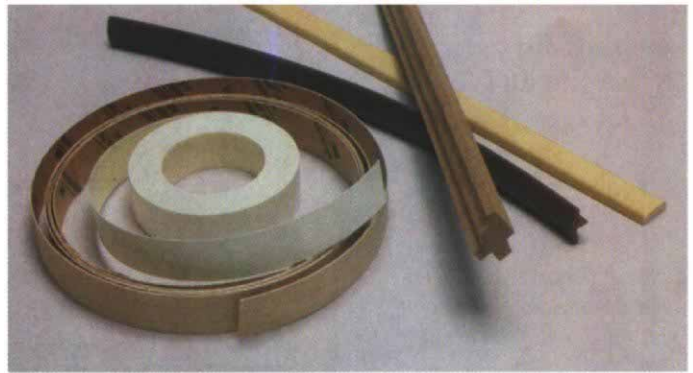
Nevertheless, some shops use MDF-core plywood exclusively for their bookshelves. They like its solid core and its cost, which is about 5% to 20% less than veneer-core plywood. Georgia-Pacific's Fiber-Ply core plywood and Columbia Forest Products' Classic Core plywood are compelling hybrids. They look like conventional veneer-core plywood, but they have homogenous layers of fiberboard instead of solid-wood plies directly beneath the face veneers.

Lumber-core plywood is strong, it holds screws tenaciously, and it is supposed to be voidless. But today's lumber-core plywood, much of which is imported, can have shrinkage voids in the core. Good-quality lumber-core plywood is expensive and can be hard to find.

Regardless of the type of plywood used, exposed edges need to be covered with moldings or edgeband (top photo). Moldings can be anything from pine screen bead to solid-wood or plastic T-moldings that fit into grooves in panel edges. Edgeband is peel-and-stick, iron-on or glue-on veneer that comes on a roll. Solid-wood, polyester and even metallic-foil edgebands are available.

Particleboard and MDF work well for paint-grade work—Particleboard and MDF are hard to beat for paint-grade shelving systems. They're relatively inexpensive and stable, and they don't require edgeband. Most lumberyards sell $\frac{3}{4}$ -in. industrial-particleboard shelving with filled bullnose edges. Available in many widths—typically 8 in. or 12 in.—precut shelving is quick and convenient.

Called the "Buick of particleboard" by Albuquerque woodworker Sven Hanson, MDF is made of highly compressed wood fibers instead of parti-



Cover exposed plywood edges with edging. Options include (top) T-molding; pine screen bead; plastic T-molding; peel-and-stick hardwood edgeband (outer roll); and iron-on polyester edgeband (inner roll).



Sheet stock is a stable and uniform choice for shelving. Options range from hardwood-veneer plywood to medium-density fiberboard panels with a durable melamine surface.

cles, resulting in panel surfaces that are as flat as glass and edges that machine beautifully without chip-out (machining produces clouds of fine dust, though, so wearing a high-quality dust mask is a must). The Home Depot in my area sells $\frac{3}{4}$ -in. MDF for about \$20 per sheet, which is a bargain.

One problem with MDF and particleboard panels is that unsealed edges drink paint, resulting in an uneven finish. You can seal MDF edges with two coats of water-based polyurethane finish, but quick-drying sanding sealers and white PVA glues diluted 20% with water will also work.

Paint-grade plywood, called MDO (medium-density overlay), can also be used for painted shelving. This exterior-grade veneer-core plywood is coated with a resin-treated paper that makes a superb, smooth substrate for paint. MDO can also be taped like drywall, so it makes a good material for built-in shelving.

MDF and particleboard can also come veneered with melamine or plastic laminate. Melamine is a thermally fused, resin-impregnated sheeting that resists abrasion, stains, heat and chemicals, and it's available in a variety of sizes, patterns and colors. The Home Depot sells melamine panels that are ripped to standard bookcase widths and that are predrilled with $\frac{1}{4}$ -in. holes that accept standard shelf pins. Melamine can be tricky to work with because it chips easily. But it's a versatile material, and it has a hard prefinished surface. (For more on working with melamine, see *FHB* #99, pp. 68-73). □

Bruce Greenlaw is a contributing editor of Fine Homebuilding. Photos by the author, except where noted.