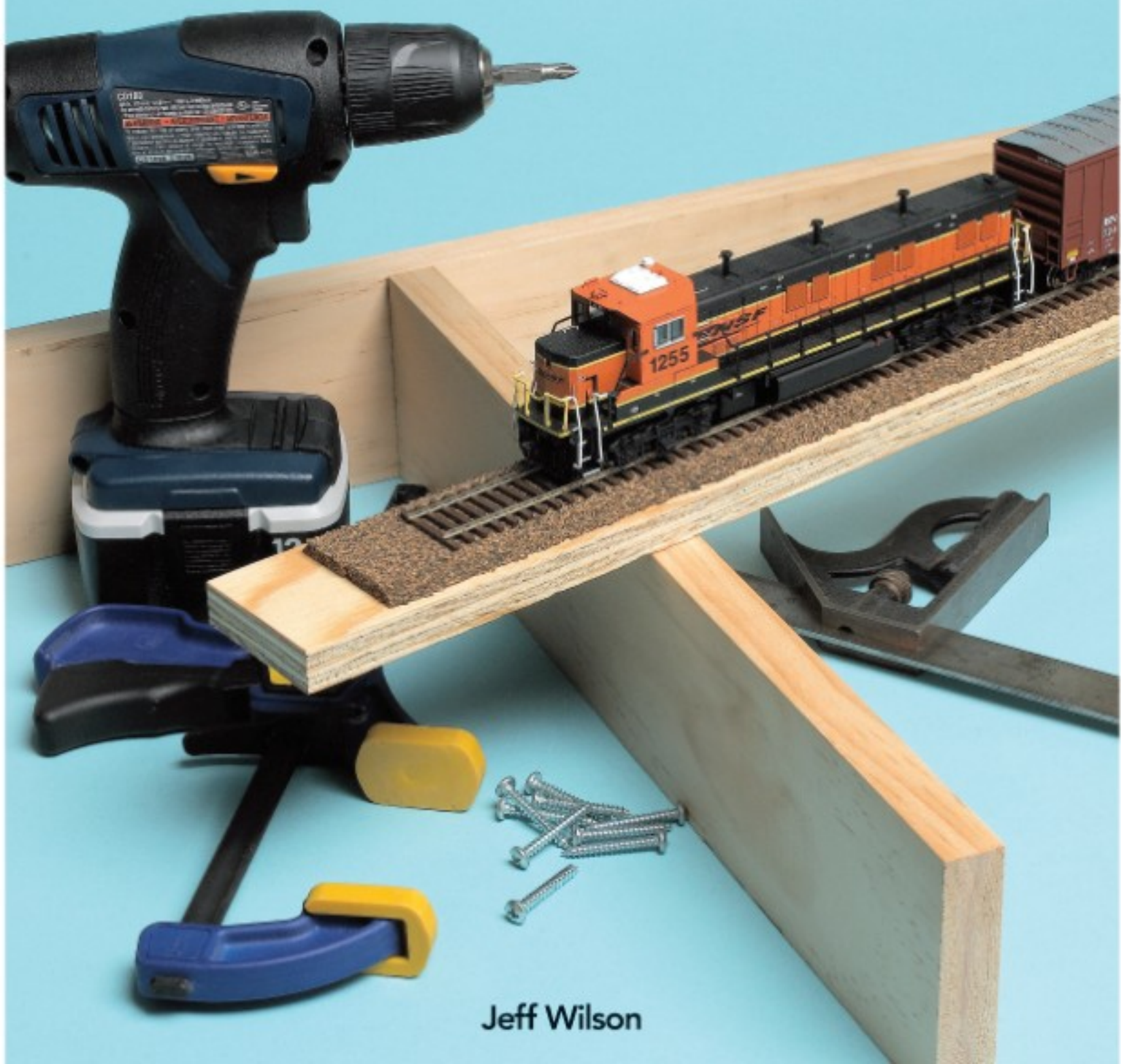


Model
Railroader

E S S E N T I A L S S E R I E S

Basic Model Railroad
BENCHWORK
— SECOND EDITION —



Jeff Wilson

Basic Model Railroad
BENCHMARK
— SECOND EDITION —

Jeff Wilson



Kalmbach Books

21027 Crossroads Circle
Waukesha, Wisconsin 53186
www.Kalmbach.com/Books

© 2012 Kalmbach Books

All rights reserved. This book may not be reproduced in part or in whole by any means whether electronic or otherwise without written permission of the publisher except for brief excerpts for review.

Published in 2012

16 15 14 13 12 1 2 3 4 5

Manufactured in the United States of America

ISBN: 978-0-89024-836-2

Editor: Randy Rehberg

Art Director: Tom Ford

Illustrator: Rick Johnson

Unless otherwise noted, all photographs were taken by the author.

Jeff Wilson has written more than 20 books on railroads and model railroading. He spent 10 years as an associate editor at *Model Railroader* magazine, and he currently works as a freelance writer, editor, and photographer, contributing articles to MR and other magazines. He enjoys many facets of the hobby, especially building structures and detailing locomotives, as well as photographing both real and model railroads.

Publisher's Cataloging-In-Publication Data

Wilson, Jeff, 1964-

Basic model railroad benchwork / Jeff Wilson. -- 2nd ed.

p. : ill. (chiefly col.) ; cm. -- (Model railroader essentials series)

Expanded, with additional material, new drawings and photos.

ISBN: 978-0-89024-836-2

1. Railroads--Models--Design and construction--Handbooks, manuals, etc. 2. Models and modelmaking--Handbooks, manuals, etc. I. Title. II. Title: Benchwork

TF197 .W55 2012

625.19

3 1223 10361 1464

Contents

Introduction	4
Chapter One	6
Tools and materials	
Chapter Two	18
Simple tables	
Chapter Three	32
L-girder benchwork	
Chapter Four	40
Open-grid benchwork	
Chapter Five	49
Subroadbed	
Chapter Six	66
Wall-mounted benchwork	
Chapter Seven	80
Multi-deck benchwork	
Chapter Eight	87
Backdrops and fascia	
Chapter Nine	94
Duckunders, liftouts, and swinging gates	
Chapter Ten	101
Benchwork as furniture	



Introduction

Benchwork serves as a solid base for your model railroad. Reliable operation on smooth-running track is dependent upon level, sturdy benchwork.

Benchwork scares many people, but this need not be the case. Benchwork is among the most forgiving of all areas of building a model railroad. It's important to give your layout a sound foundation, but for the most part, appearance is secondary since virtually all of your benchwork will eventually be covered by track and scenery.



Model Railroader staff built this HO scale layout, based on the Virginian Railway. The select pine benchwork is sturdy, casters on the legs allow it to be rolled across the floor, and its neat appearance nicely complements the layout.

The wide array of tools available today, including affordable power drills and saws, makes it relatively easy to assemble benchwork for even large layouts in a matter of days. You can get solid results even if you've never done any woodworking before, provided you take your time and follow sound design and construction ideas and methods.

This book provides directions, photos, and drawings for building many styles of benchwork and explains many situations you'll come across. However, it's best to use this as an idea book—depending upon the space you're working with, different methods may be better choices than others.

You should have already established your track plan before designing and building your benchwork. There are many fine track planning and track plan books on the market, along with plans that appear in model railroading magazines. Whether designing your own plan or using (or modifying) a published plan, I highly recommend reading John Armstrong's *Track Planning for Realistic Operation* (Kalmbach Books, 1998).

Whether you're using a published plan, modifying an existing plan, or designing your own, here are a few points to consider:

- Keep all trackwork within arm's reach of the aisle or access area. This varies depending upon your size and reach and the height of the layout (the taller the layout, the shorter your reach becomes). Even scenic elements located more than 30" from the layout's edge will eventually need to be dusted, adjusted, or repaired, and if it's not convenient to reach, it won't get done. Any table wider than 36" should have access from both sides.

- Avoid operating areas, or pits, that are trapped within layouts. Shelf-style walkaround layouts (or stand-alone tables with peninsulas) have become the norm for room-size and larger layouts because they're much easier to work on and operate. After all, how many times do you really want to get on the floor and crawl to an access area to build or run a layout?

- Avoid duckunders and liftout sections whenever possible. They are often an attractive feature when drawing a track plan, and sometimes they are unavoidable, but they can hinder operations.

New edition

This second edition of *Basic Model Railroad Benchwork* takes much of the material from its first edition (published in 2002) and combines it with material from Kalmbach's classic benchwork book, Linn Westcott's *How to Build Model Railroad Benchwork*. It also incorporates drawings, photos, and information from benchwork articles that have appeared in *Model Railroader* magazine.

- Plan for aisles. Make sure all aisles are as wide as possible—at least 24" and preferably 30" to 36". Long, narrow aisles should contain wider areas that allow two operators to comfortably pass each other.

- Avoid hidden (below main level) staging tracks if possible. If you must have hidden track, keep it simple with as few turnouts as possible, and make sure you provide access to clean the track and fix derailments.

- Be creative. This book can only suggest methods for accomplishing your goals. It can't show you exact blueprints for the specific benchwork to fit your space. Use your imagination for tackling unique situations that confront you.

Many modelers ask what the "best" benchwork method is, but the answer is that there simply is no one best way to build benchwork. You can choose open-grid or L-girder, freestanding or attached to the walls, foam shelves, steel-stud benchwork, or a combination of styles—all can work well. Your choices will depend upon the space available, your final track plan, and whether you can attach benchwork to walls. Use the methods you feel will work best in your space and situation and the ones you're most comfortable building.

The key is to have a specific plan for your benchwork, just as you do for your track plan. Prepare a detailed sketch of your benchwork plan. This will help you estimate the materials you'll need and will help reveal any major problems before construction begins.

Turn the page, and we'll start by looking at the various materials you have at your disposal and the tools it will take to do the job.



Tools and materials

Lumber, foam, and fasteners

Basic power and hand tools, combined with the proper materials, can speed the benchwork process.

Make sure you have the necessary tools to build benchwork, **1**. Knowing how to use them can make a big difference in the quality of your work, and it can also save you a great deal of time.



2
A combination cordless drill and driver is the handiest power tool you can own. Several types of driving bits are useful, including reversible and separate Phillips, standard, and square-drive bits.

It's also a good idea to understand the materials you'll be working with. All 2 x 4s aren't created alike. There are many types of lumber and plywood, along with fasteners and other materials, out there. Some work better than others in different situations, and knowing what does which job best can save you time, money, and frustration. Let's start with a look at tools.

Once considered luxury items, power woodworking tools are now quite affordable. A couple of choice power tools will dramatically decrease the time required for a project while increasing the quality of the finished product.

Safety glasses



Protect your eyes when building benchwork or doing any other model railroading task. Not only should you wear safety glasses when operating power tools, you should also wear them whenever you're hammering or driving nails, soldering, using a hot-glue gun, or doing any other job where small bits of wood and metal could go flying.



3
The table on a compound miter saw rotates to allow cuts at angles to just beyond 45 degrees. The blade can also be angled.



4
Saw tables, such as the TableMate, are handy for supporting lumber while it's being cut.

Cordless drill

One tool that I consider a necessity is a cordless drill and driver, **2**. It's among the most versatile and useful tools you can have around the house, and you'll use it for many tasks other than building benchwork.

Today's cordless drills have all the torque you'll need for both drilling holes and driving screws. Choose one with a $\frac{3}{8}$ " keyless chuck. It should also have at least two speed settings. High-quality cordless drills are made by DeWalt, Ryobi, Black & Decker, and others. Most of the price differential is based on battery pack voltage.

In general, the higher the voltage, the more torque it has and the longer the battery will last. Most drills come with two battery packs, so you can have one charging while you're using the other.

For most of us, a 9- to 12-volt drill provides more than enough power. Drills up to 24 volts are favored by pros, who subject their tools to constant daily use. The tradeoff is that their battery packs are larger and heavier, as well as more expensive.

You'll need drill bits in various sizes. The sidebar on page 10 explains the different types of bits available and their uses. You'll also need screwdriver



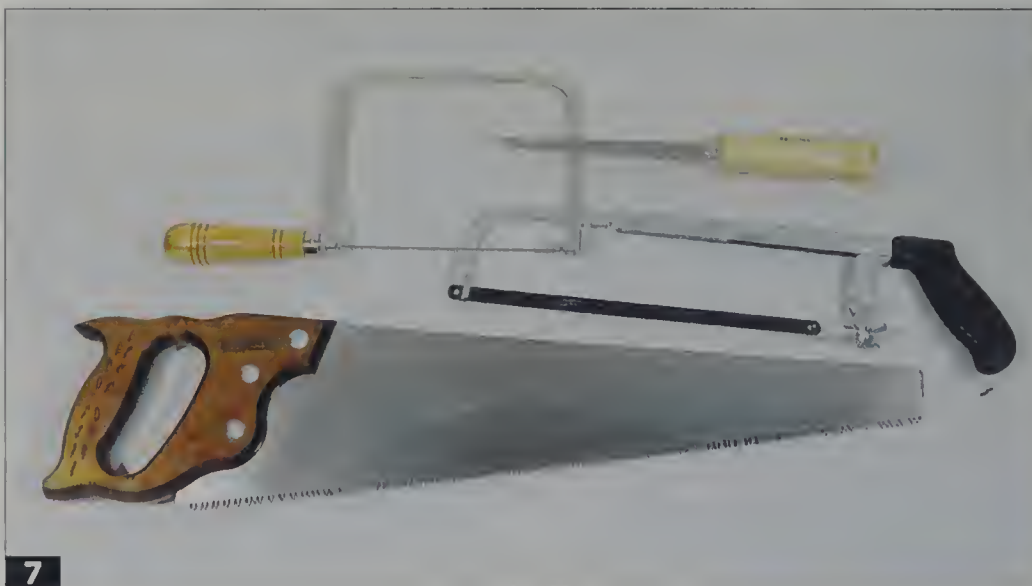
5

Handheld power jigsaws (saber saws) are used to cut curves in plywood, hardboard, and other material.



6

Circular saws make straight cuts in large sheet material and can also be used to make square and angled cuts in dimensional lumber.



7

Common handsaws include (clockwise from bottom) crosscut, coping saw, drywall saw, and hacksaw.

bits, including Phillips, standard, and square-head drivers. Most drills include a combination reversible Phillips/slotted bit.

Power saws

Number two on the power tool list is a saw. Table saws are extremely versatile, but they also take up a lot of space. Don't buy one just to build benchwork, but if you already have one, you'll find it very handy, especially for ripping large sheet material.

A better choice for most model railroaders is a power miter saw. These make quick, precise cuts in strip material. The simplest ones, sometimes called chop saws, do just that—pulling the blade down to the table cuts the material. The table rotates to make miter cuts at different angles.

Compound miter saws are a step up, allowing you to adjust both the blade angle and the table, 3. These can be simply placed on a workbench, or they can be mounted to a table. Many commercial workstands are available for holding miter saws, 4. These do a good job of supporting the material being cut.

Check capacity when buying a miter saw. Smaller miter saws use 8" blades; others have 10" blades and can cut material up to 6" wide and 4" deep. And, if you really want to get fancy, sliding compound miter saws have blades that slide out on an arm, allowing them to cut material up to 10" wide.

A power jigsaw, also called a saber saw, 5, is the handiest tool for shaping curves, especially when cutting plywood roadbed or hardboard fascia contours. Blades are measured in teeth per inch (tpi): the more teeth per inch, the smoother the cut but the slower the cutting. Use 5 tpi blades for rough work and at least 10 tpi for smooth cuts.

If you don't have a table saw, a circular saw works well for straight cuts in large sheet material, 6. Most circular saws come with combination blades, making them useful for both ripping (cutting wood along the grain) and crosscutting (cutting across the grain).

With any power tool, take appropriate precautions to ensure safety. Always unplug saws before changing or oiling blades, and always wear approved safety glasses when cutting any material. Hearing protection—either full over-the-ear muffs or in-ear plugs—should be worn when using saws, vacuums, and other loud power tools.



8 Coping saws are designed to cut while the user is pulling down, as when cutting a curved corner in a piece of plywood.

Handsaws

With the many power tools on the market today, it's easy to forget that hand tools are still very important in working with wood and other materials.

Several types of handsaws come in handy for model railroaders, **7**. A good-quality crosscut saw will prove useful in cutting dimensional lumber as well as plywood. As the name implies, they are designed for cutting across the grain of the wood.

Like other saws, handsaws are measured in teeth per inch. Saws with many teeth per inch will cut slower but produce a cleaner cut; saws with fewer teeth per inch will cut quicker and more easily, but the cut edges will be rougher. I've found the Stanley 7 tpi saw shown in photo **7** to be a good general-purpose saw, but I also have a 10 tpi saw on hand for smoother cuts.

For making fine curved cuts by hand, use a coping saw, **8**. Keep the blade perpendicular to the surface. Note that coping saws are designed to cut with the saw pulling down—not being pushed like a crosscut saw.

Keyhole and drywall saws are designed for cutting holes in closed areas; you can start them by drilling a hole in the material large enough for the saw blade to pass through. With these saws, it is important not to get too exuberant—if the saw pops up through the hole, the result is often a



9 Small miter boxes typically have grooves cut at 90 and 45 degrees. The cut is made pushing against the far wall.



10 Oiling each side of a saw blade helps prevent binding and keeps blades from rusting.

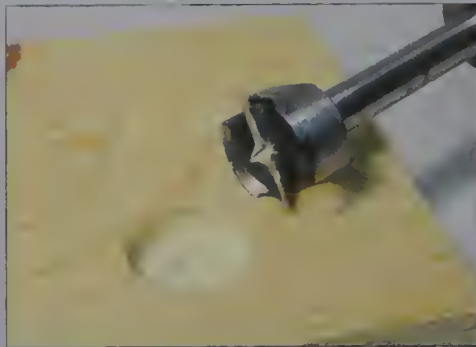


11 Screwdrivers come in many blade sizes and shaft lengths. The curved-handle screwdriver at left is handy for getting into tight spaces.

Drill bits



Popular drill bits include (from left) spade, Forstner, twist, and twist with spade point.



Forstner bits are the best choice when you need a perfectly round hole or one with a flat bottom.



Bits are available in sets of commonly used sizes. A set that includes a case helps keep bits organized.



Quick-change reversible bits are very handy. This DeWalt bit has a collar that snaps in and out to release the head, which can be flopped end for end. The driver and drill bit are both replaceable, allowing you to change sizes and styles of bits as needed.

Standard twist bits are good for general use in wood and metal. Steel bits are economical and work well for wood; carbide bits are more expensive but will last longer and are suitable for drilling metal.

Spade bits are flat with a point in the middle. They essentially drill their own pilot holes and then finish the hole by carving out the rest of the opening. They make it possible to drill holes larger than the shaft capacity of your drill, but they are rough-cut bits: they can splinter materials easily and leave a slightly out-of-round hole.

Forstner bits are a better choice for drilling large holes when precision matters. They have two advantages: they drill a very clean, round hole, and they are the bit to use if you need a hole with a flat bottom.

Use countersinking bits when drilling pilot holes for flathead wood screws to set the head of the

screw flush with the surface. These bits are available in numbers (4, 5, 6, 8, 10) that match wood screw sizes (the smaller the number, the narrower the shaft). Since screws come in a variety of lengths, most countersinking bits have a small set screw on the side of the bit to permit adjustment for a deep or shallow hole.

Reversible bits have a quick-change reversible head that has a countersinking bit on one end and a screwdriver head on the other, making quick work of drilling pilot holes and driving screws. The one pictured is from DeWalt; many styles and makes are available.

For starters, I recommend buying a set of twist drills from $\frac{1}{16}$ " to $\frac{3}{8}$ ", along with $\frac{1}{2}$ " and $\frac{3}{4}$ " spade bits and Nos. 8 and 6 countersinking bits. You can buy an inexpensive set at first and then replace them with higher-quality carbide bits as the originals get dull.

bent blade and, if you don't have your other hand clear, a nasty cut. I've found that these saws are also quite handy for rough-cutting sheets of extruded foam board.

Hacksaws are designed for cutting metal. They have thin, replaceable blades with fine teeth. Don't use them to cut wood—the blades will bind easily.

If you don't have a power miter saw, you can use a hand miter saw and miter box for precision cuts, **9**. Miter saws have fine teeth and a narrow profile, designed specifically for use with the miter box. The box in the photo has grooves cut at 90 and 45 degrees. More expensive models have the saw in a bracket above the cutting surface, with the bracket being able to be adjusted to any angle.

Saws (hand and power) can get hot during use, and a hot, dry blade tends to bind. Periodically oiling blades will keep them working smoothly and will keep blades from rusting, **10**. Be sure to unplug power saws before oiling their blades. Simply squeeze a few drops of 3-in-1 or other light oil onto a paper towel or cloth and rub it on the sides of the blade above the teeth.

Be sure to mark wood to be cut, and keep the saw blade to the right of the cut line (to the left if you're left-handed). Don't try to force the saw through the wood—let the saw do the work.

Screwdrivers

The two most common types of screwdrivers are standard (slotted) and Phillips (cross pattern). However, screwdrivers come in a variety of sizes, with long and short shafts and blades in small, medium, and large sizes, 11.

It pays to have at least two sizes of each on hand. Whether using a screwdriver or a power driver, it's important to use the proper size bit, 12. Using too large or too small a screwdriver can damage both the screwdriver and the screw, 13.

Squares

When building benchwork—or anything else in wood, for that matter—it's important to keep pieces square with each other. Several types of squares will work in various situations, 14. Combination and try squares are handy for marking 45 and 90 degree angles in dimensional lumber.

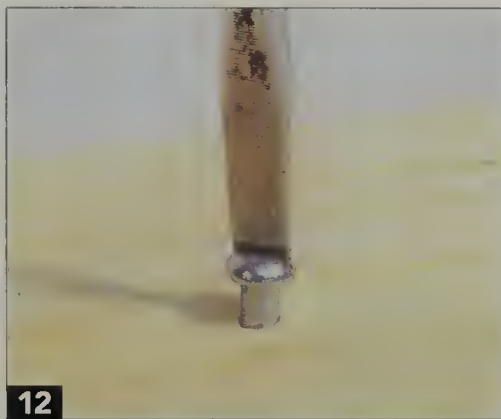
Framing squares (also called a carpenter's square) are simple L shapes, typically with one arm 18" long and the other 24". They're useful for marking larger material and checking the square of pieces at a joint.

If you're marking or cutting a lot of plywood, foam, or other large sheet material, you'll find a drywall square invaluable. As the name implies, it is designed for marking and cutting drywall, but it works well for other material. It has a 4-foot-long arm and a 22" T to reach all the way across a 4-foot-wide sheet of plywood.

Clamps

Clamps hold pieces in place or together while you measure, level, and fasten them. In building benchwork, you'll find that you'll need several clamps of various styles, 15.

Traditional C-clamps are a popular choice, and they are available in many sizes—those with 4" jaws are the handiest for benchwork. Tightening the threaded rod grips the material in the clamp and results in a very strong joint. However, they can take a while to adjust, and they can mar the surface being clamped, so use a thin piece of



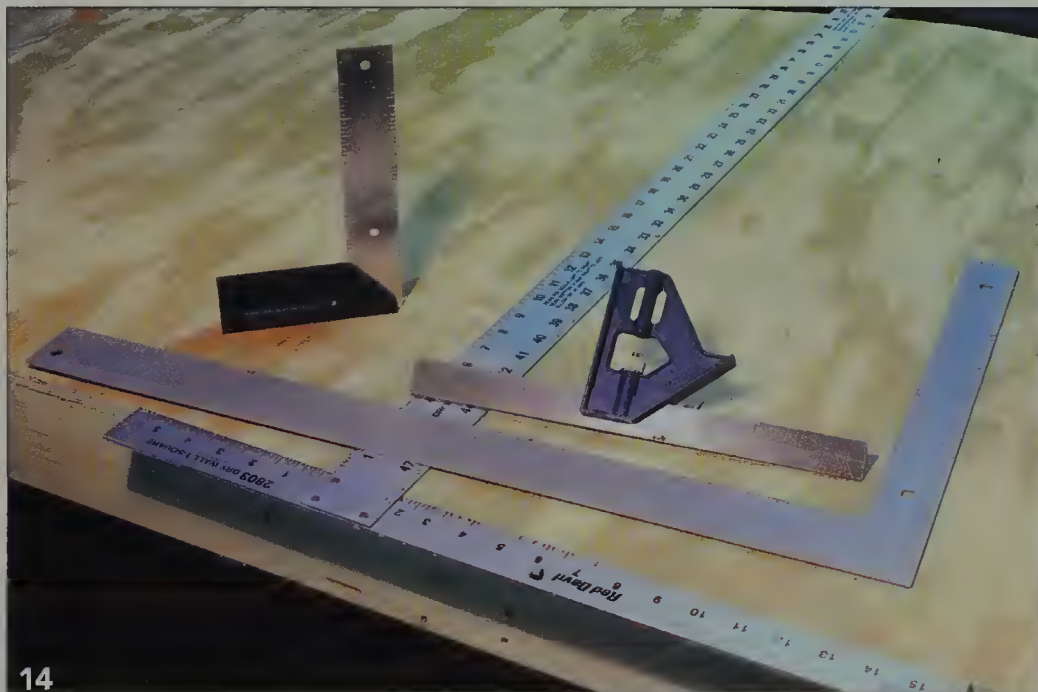
12

Regardless of the type of head (slotted, Phillips, square, or other), a screwdriver blade should fit solidly in the notch of the screw.



13

Screwdrivers that are too big can slip and damage the screw or work surface. Using a screwdriver that is too small can also damage the screwdriver.



14

Types of squares include (from bottom) drywall, framing, combination, and try.



15

You'll find conventional C-clamps as well as quick-release bar clamps handy for building benchwork.



16

Other useful tools include a hammer, tape measure, utility knife, sanding block, Stanley Surform plane, and files.

scrap wood between the clamp and the work.

Bar clamps (Quick Grip is one brand) use a squeeze trigger to apply pressure. A quick-action release lever allows you to slide them in and out of position quickly. These clamps have rubber-padded grips and won't hold as tightly as a C-clamp, but they won't mar material, and they work for most benchwork applications. Like C-clamps, they are made in many sizes, with the 6" capacity the most useful for benchwork.

Miscellaneous tools

You'll also need several other tools, 16. A claw hammer is a must for driving (and removing) nails and tacks.

A good tape measure is indispensable. I have a sturdy 25-footer, which is helpful for checking room and overall layout dimensions, and a 16-footer, which is smaller and lighter, making it ideal for general use.

Files in a variety of lengths and shapes are handy for smoothing edges and corners on wood. A rasp, such as a Stanley Surform tool, is great for cleaning up rough edges on wood and for shaping and contouring foam.

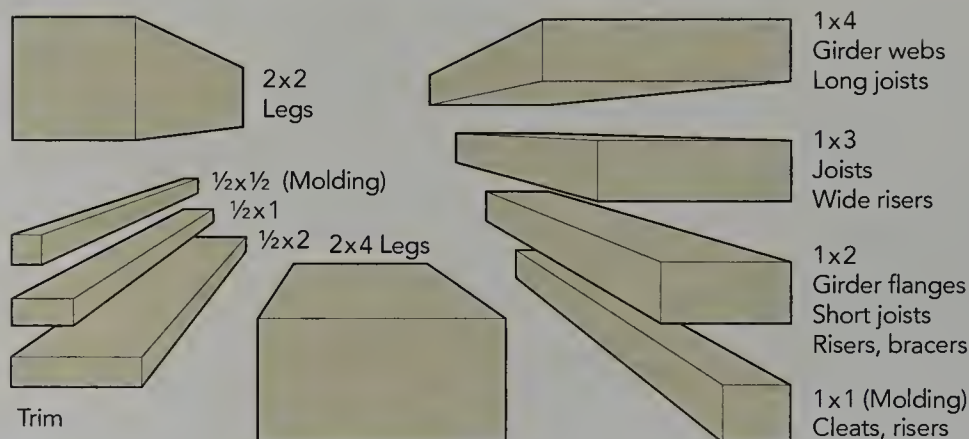
You'll find many uses for sandpaper in grits from 60 (coarse) to 220 (fine). Give your fingers a break and buy a couple of hard-rubber sanding blocks. These will save you from accidental cuts and blisters. I keep two handy, with coarse sandpaper on one and fine on the other.

A good utility knife is much handier than a hobby knife for cutting and carving heavy cardstock, thin wood, foam core, and other materials. Keep a supply of replacement blades, and if a blade chips or becomes dull, replace it.

Benchwork materials

The amount of construction materials and products available is staggering: lumber, plywood, OSB (oriented strand board), particle board, hardboard, foam,

COMMON BENCHWORK LUMBER



17



18

These 1 x 4s show, from top to bottom, select grade, No. 2 and better, and No. 3.

LUMBER DIMENSIONS

Nominal	Actual
1 x 2	3/4" x 1 1/2"
1 x 4	3/4" x 3 1/2"
1 x 6	3/4" x 5 1/2"
2 x 2	1 1/2" x 1 1/2"
2 x 4	1 1/2" x 3 1/2"

Dehumidifiers

Most problems with expansion and contraction on a layout are caused by humidity changes that affect dimensional lumber. Problems can include cracked scenery, gaps or kinks in rails, buckled subroadbed, and liftout sections or swinging gates that no longer fit properly. These problems are exacerbated in basements, where humidity can range from less than 20 percent in winter to more than 70 percent in summer.

If you have a layout in a basement, even one that seems dry, it's wise to run a dehumidifier during the humid summer months. Keep a humidity gauge near your layout, and if the gauge goes above 50 percent, turn up the dial on the humidifier. Humidifiers are rated by the space they can cover; check the manufacturer's specifications, and buy one with a capacity that matches your layout space.

plastic, and steel, to name just a few. In addition to the materials themselves, an impressive array of glues is available as are screws, nails, and other hardware.

With such a variety, it's important to understand what the different materials are designed for and what their strengths and weaknesses are.

A key point to remember is that most of what we do in assembling benchwork will be covered up by scenery. The most important criteria are that benchwork be sturdy, durable, and square. There's no need to pay extra for (or do extra work on) cosmetic features that will later be hidden.

Most of our work is done with lumber and wood-based products, so we'll look at these materials first.

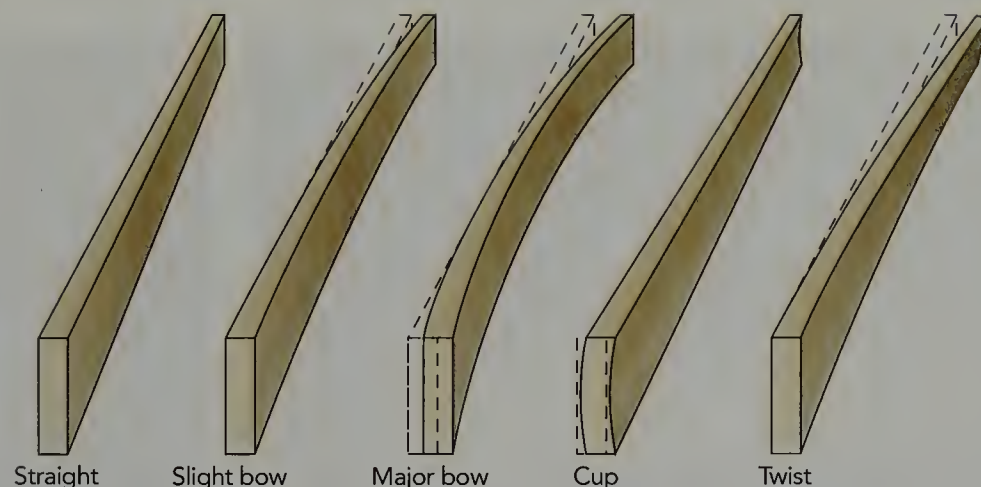
Dimensional lumber

Dimensional lumber (in the form of sawed boards or planks) is the basic material for many types of benchwork, 17. Stick to soft woods like pine or fir, which are readily available and far cheaper than hardwood.



19 Avoid boards like this 1 x 2, which has a knot that severely compromises its strength.

FLAWED BOARDS

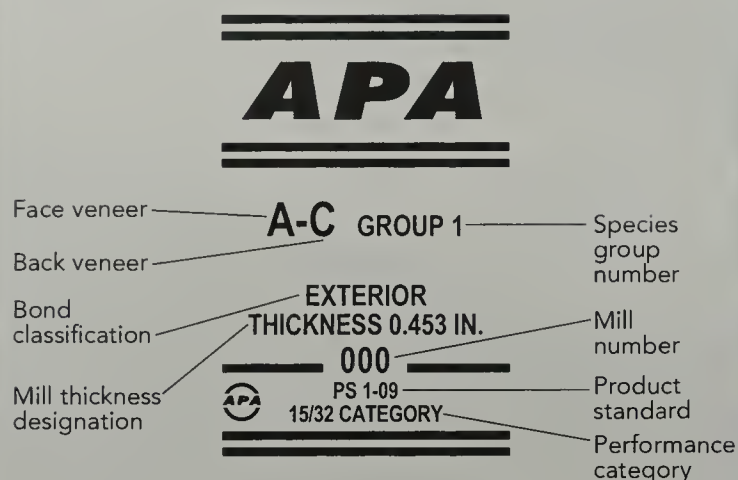


20



21 Plywood is made of three or more plies of wood glued and bonded together under high pressure. Shown here are standard 1/4", 1/2", and 3/4" pine or fir plywood.

TYPICAL STAMP



22

Information stamped on plywood includes grade (A-C), size, species group, and whether it is rated for interior or exterior use. *APA – The Engineered Wood Association*

It is important to note that a finished 2 x 4 is not 2" x 4" (which is why lumber descriptions are never written with inch marks). A 2 x 4 is actually 1½" x 3½". This is because the original rough-cut board has been planed smooth on all four sides, taking it down a quarter inch on each side. Other true dimensions for dimensional lumber are listed in the chart on page 12.

For benchwork, you should use kiln-dried, untreated lumber. Lumber comes in several grades, based on the number and size of knots and the slope of the grain. Lumber rated as select or select structural is nearly free of knots and has a broad grain slope, **18**; after that comes Nos. 1, 2, and 3. Number 1 has the fewest and smallest knots and broadest grain, while No. 3 has more and larger knots and more grain curvature.

Select lumber can cost four or five times as much as No. 3, so use it only when appearance really matters. Numbers 1 and 2 are often grouped together (usually as No. 2 and better) and is most often the best choice for benchwork. The knots are generally small, and it's generally not too difficult to find straight No. 2 or No. 3 boards.

Be picky about choosing wood. The two most critical factors are that it should be straight and that it should not have any large knots or other defects that compromise its strength. If a knot is more than a quarter of the width of a board, discard it, **19**.

Figure **20** illustrates different types of boards that are imperfect: bowed, cupped, and twisted. Lumber that's slightly bowed or cupped can still be usable. However, if a board has a twist, discard it—a twisted board will throw off the squareness of an entire project.

Information on grades and type of dimensional lumber is usually stamped on the wood itself or found on a sticker or a label. The information regards size, grade, sanding (S4S means sanded on four sides), and moisture. S-Dry means that the board has less than 19 percent water weight, and S-Grn (green) means that water content is higher than 19 percent. Be sure to buy S-Dry wood to minimize shrinking. Also, when buying lumber, make sure that boards haven't spent time in a damp area of the lumber yard.

Dimensional lumber is prone to expansion and contraction along its length, caused mainly by variances in humidity. When you get the lumber home, store it in your layout area for at least a few days to allow it to adjust to the temperature and humidity of its new environment. It's not always possible, but ideally you should let it sit for a full year to complete a full rotation of seasons. Dry winter conditions, followed by damp spring and summer weather, can cause problems. A dehumidifier is a wise investment (see page 13). Let it run in your basement from spring through fall to keep humidity levels within reason.

23

Particle board (top) and OSB (bottom) are both made of sawdust and wood chips bonded into a sheet. Particle board is dense and smooth; OSB has a rougher texture.

Plywood

Plywood is the most-used material for subroadbed and tabletop surfaces for good reasons: it's dimensionally stable, relatively easy to work with, and can easily be fastened by screws, nails, and glue. Plywood is also used for shelves, fascia, control stands, and many other areas requiring flat sheet material.

The most common plywood size is the 4 x 8-foot sheet, but many lumber yards and home centers offer smaller sheets such as 2 x 4 feet and 4 x 4 feet. You can also get larger sheets, including 5 x 9 feet and 4 x 12 feet.

Plywood is made up of several layers, or plies, of wood veneer glued on top of each other, **21**. The grain in each succeeding layer is at a right angle to the one below it (except for four-layer plywood). This gives plywood excellent strength and makes it resistant to shrinkage caused by changes in temperature or humidity. Nominal thicknesses range from ¼" to ¾" in ⅛" increments, but the actual sizes are a bit off. Thus, ¼" plywood is actually ⅞", ½" plywood is ⅝", and ¾" plywood is ⅔".

Like dimensional lumber, plywood comes in several grades, with the information stamped on the board, **22**. You'll see a rating of A through D to describe the finish, with A the best and D the roughest. For example, A-C means that the top is finished and sanded, with knots filled, but the back is unfinished. Either A-C or



24

Hardboard, such as this $\frac{1}{8}$ " sheet, is a dense fiberboard that is usually tempered on one or both sides, giving it a smooth, hard surface.



25

Homasote, a nontempered fiberboard commonly used for insulation, is an excellent roadbed material.



26

Extruded foam insulation board comes in various thicknesses, including these $1\frac{1}{2}$ " pink and 2" blue sheets.



27

Drywall has plaster sandwiched between paper surfaces. The edges of each sheet are beveled slightly to make it easier to join them with drywall tape and joint compound.

B-C works best for most benchwork uses.

One often-overlooked piece of information found on the stamp is the wood species group number. Use Group 1 plywood if possible, as it is the strongest and stiffest. Group 2 is the next best.

Other sheet material

Particle board is a heavy, dense board made from sawdust and woodchips glued (bonded) together, 23. Because it is difficult to easily drive staples, track

nails, and other small fasteners into it, particle board is too hard for many benchwork uses. It is also much more prone to sagging than plywood, making it a poor choice for subroadbed and shelving, and it will deteriorate quickly if it becomes wet.

Waferboard and strandboard (OSB) are similar to particle board but contain larger pieces of wood, 23. These materials are designed for sheathing. Their hard, rough surfaces limit their use in benchwork, but since OSB tends to be less expensive than plywood, you

can use it where a smooth finish isn't required.

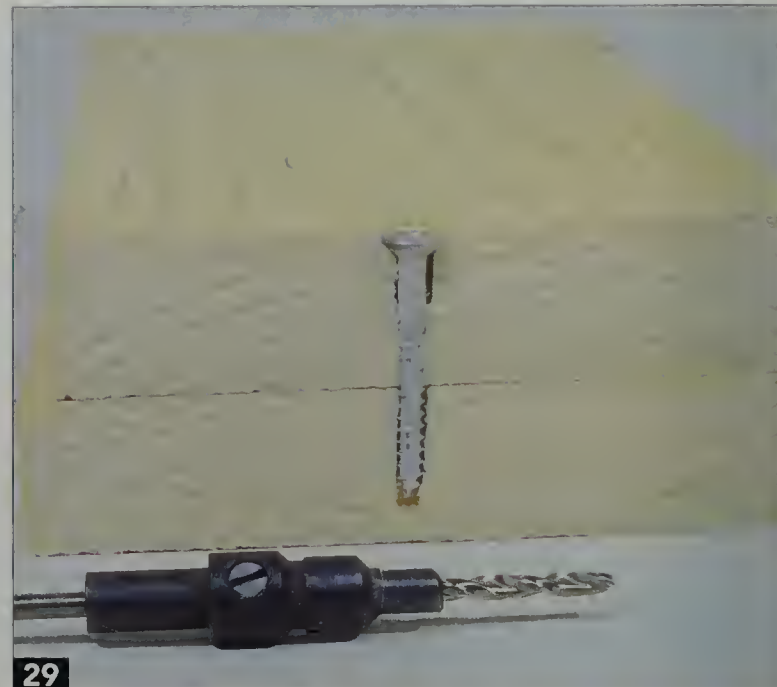
Tempered hardboard (Masonite is one brand) is made from wood fibers and resins bonded under high pressure. The result is a very smooth, hard surface on one or both sides, 24. Hardboard is an excellent choice for backdrops, fascia, and control panel facing. It comes in $\frac{1}{8}$ " and $\frac{1}{4}$ " thicknesses; the thin variety is much more flexible.

Homasote is a light-density fiberboard used as construction insulation, 25. It is soft enough to push nails and



28

Screws come in many shapes and sizes, including wood screws with flat and round heads in Phillips or slotted styles. Some have combination slotted/hex heads. A bolt (far right) looks similar but isn't designed for use without a nut.



29

This cutaway view shows how drilling a pilot hole with a countersinking bit allows slotted screws to drop at or below surface level.

track spikes into by hand (while still holding them securely), making it an excellent roadbed material. It can be difficult to find in many areas.

Foam board and drywall

Extruded polystyrene insulation—often called simply foam board—has become a popular material for scenery and is sometimes used in benchwork. It is lightweight, fairly strong, and easy to cut and work with hand tools, 26.

The material is usually blue or pink (sometimes gray or yellow) depending upon the manufacturer. It is typically available in 1", 1½", and 2" thicknesses in 8-foot-long sheets in 16", 18", 24", and 48" widths. It can be difficult to find in warmer climates, but most large lumber yards and home centers stock it or can order it. Avoid the white beaded foam board, which isn't as strong.

Foam is easy to cut with a knife (serrated steak knives work well) or a saber saw with a knife blade. It can be shaped with Stanley Surform tools.

The best glues to use on foam are Liquid Nails for Projects, Woodland Scenics Foam Tack Glue, or water-based contact cement. Be aware that solvent adhesives (including plastic cement and cyanoacrylate adhesive (CA) will melt foam.

Drywall or plasterboard (Sheetrock is one brand) is a hard, dense board made of plaster sandwiched between

paper sheets, 27. It is made from ¼" to ⅝" thick and can be used for backdrops and other vertical surfaces. It can be easily cut with a knife. It doesn't flex, so hardboard is a better choice for curved backdrops and fascia.

Fasteners

Nails aren't quite obsolete, but with the popularity of the cordless drill, screws have become the easiest way to secure joints. Screws hold more securely than nails, and it's easier to keep boards in alignment while driving a screw than when banging nails with a hammer.

Photo 28 shows a variety of wood screws. Use flathead screws if you want the screwhead flush with the surface, while round-head screws can be used in other places.

Screw size is measured by length plus a number based on diameter—the larger the number, the bigger the screw. Number 8 screws are adequate for most benchwork uses; No. 6 screws work in areas where not as much strength is required. Screws should be long enough to penetrate the bottom piece of lumber being joined, while securely holding the top piece.

Drill pilot holes for wood screws and countersink the hole when using flat-head screws, 29. The pilot hole should be slightly smaller in diameter than the barrel of the screw. Special countersinking drills (matching specific drill sizes) are available.

Drywall screws have become popular for most general applications, replacing wood screws, 30. Drywall screws are designed to pull drywall tight against wood, but they're inexpensive and faster to use. Their narrower profile is less prone to splitting wood, so pilot holes usually aren't needed (although I still drill small pilot holes when adding screws near the ends of dimensional lumber). They can be used to join wood to wood or any type of sheet material to wood. They're available with thin and coarse threads. The coarse threads go in faster and are less prone to stripping the material. A cousin to drywall screws is the deck screw. These stainless-steel screws are strong and won't rust.

Make sure a screw is secured to something solid. Screws should be used with anchors with drywall or masonry—more on that in Chapter 6.

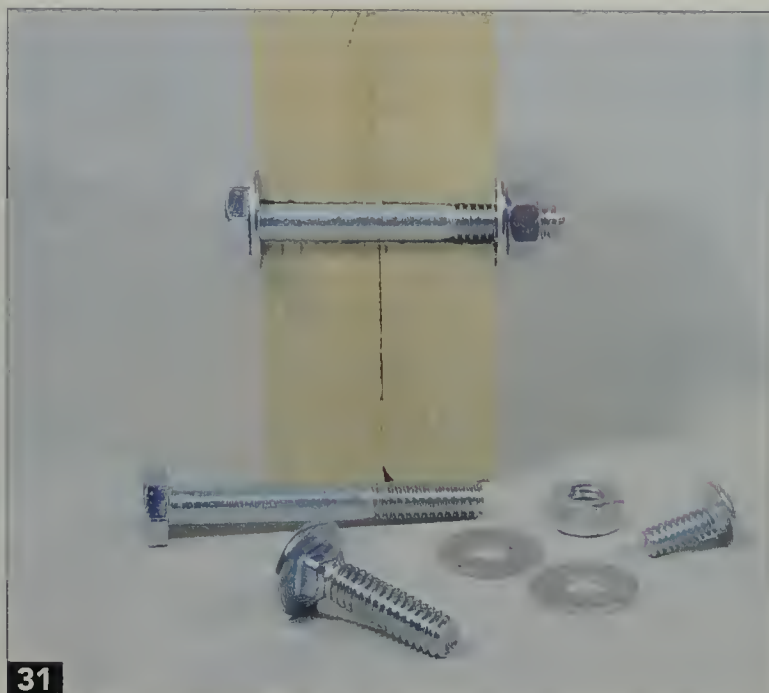
Use bolts when you need a very strong joint (such as fastening a leg to a frame or two frames to each other), 31. They're also a good choice when you need to make a piece easily removable.

Several types of nails are available, 32. Common nails have large heads and are designed for use where appearance isn't a factor. Finishing nails have small heads and are designed to be driven flush to the wood surface. Wire nails are small and narrow, and can have flat



30

Useful screws, from left, include a 3" stainless steel deck screw with square-drive head and 2 1/2" and 1 1/4" coarse-thread drywall screws.



31

Hex and carriage bolts are available in a variety of lengths and shaft diameters. These 1/4" bolts, together with nuts and washers, are handy for benchwork.



32

Types of nails include masonry, common, finishing, drywall, galvanized roofing, and wire.



33

Some of the most commonly used adhesives are carpenter's glue (aliphatic resin), white glue, polyurethane glue, and latex construction adhesive.

or rounded heads. Other specialty nails include drywall nails (which have small ridges on the shaft, resembling screw threads), galvanized roofing nails, and masonry nails.

Nail length is designated by penny sizes, with a d suffix. The larger the number, the longer the nail: a 2d (two-penny) nail is 1" long, a 4d nail is 1 1/2", a 6d nail is 2", and so on.

Adhesives

A few basic adhesives will get you through building benchwork, 33. For

gluing wood to wood it's tough to beat yellow carpenter's glue. It's water-based and impervious to water once dry, sets quickly, and provides a very strong bond.

White glue has many of the same qualities but doesn't contain the fillers of carpenter's glue and isn't as strong. It's still good for lesser duties such as gluing roadbed to subroadbed.

For joining dissimilar materials, use a construction adhesive such as Liquid Nails. There are many types, including Liquid Nails for Projects,

which is safe to use on plastics and foam board, and Heavy Duty Liquid Nails for bonding wood to concrete walls or floors.

Polyurethane glue (such as Gorilla Glue) expands as it dries, filling gaps and providing a strong bond joining wood to nonporous materials such as metal, ceramics, and coated particle board such as Melamine.

Foam-specific glues, such as Woodland Scenics Foam Tack Glue, are good for gluing foam insulation board and foam core.



Simple tables

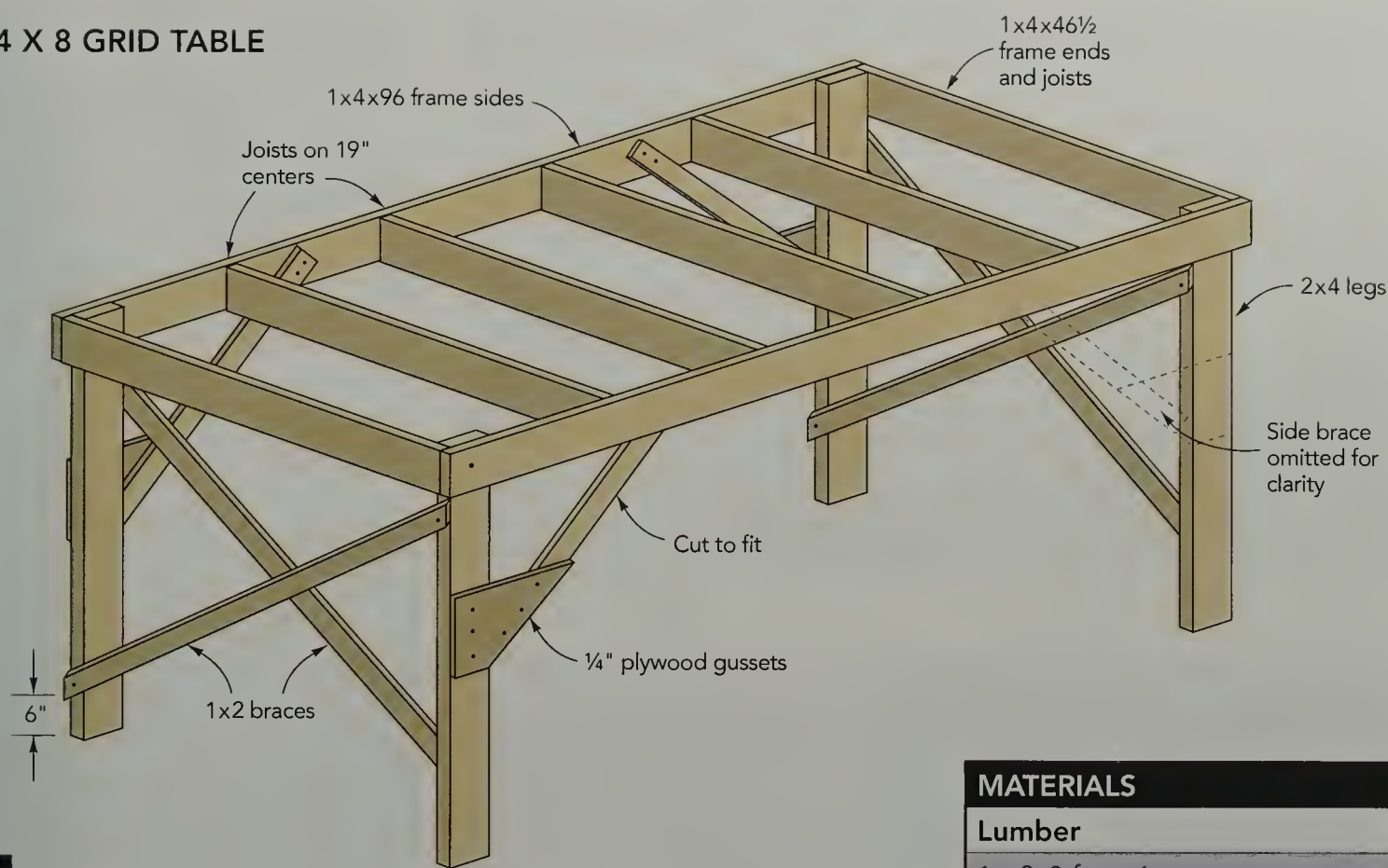
Solid bases for freestanding layouts

Many model railroaders start out by building a small table layout. This one features grid-style construction made from plywood, but there are many other benchwork options available.

Jim Forbes

A basic freestanding table is the first layout for many—if not most—model railroaders, **1**. It seems logical: building a table underneath a sheet of plywood or hollow-core door is an easy way to get a layout up and running. Table layouts do have many advantages. They're easy to build, access is generally open all around them, and if your goal is to build a portable layout, a table is the easiest to set up and take down.

4 X 8 GRID TABLE



2

However, table layouts have drawbacks. They take a lot more space than you would think—something not readily apparent when you're looking at a 4 x 8 sheet of plywood. For example, to make a 4 x 8 layout fit in a room and be usable, you'll need at least 2 (and preferably) 3 feet of space around it on all sides. This means that a 4 x 8 layout actually needs about 10 x 14 feet of space.

Track plans for table layouts can be rather limited. Curves must be necessarily tight to keep the track on the table, so it's tough to run large locomotives, passenger cars, and long rolling stock. It's difficult to add dramatic scenic elements, such as a large bridge, a turntable with a roundhouse, or a mountain, because large individual elements tend to dominate the layout and do not allow room for much else.

This doesn't mean you shouldn't build a table—just be sure to look at all of the alternatives, such as shelf designs, before beginning construction.

If you decide to go with a table, there are several designs to choose from. Grid tables (sometimes also called butt-joint tables) are ideal if you're looking for a simple square or rectangular layout. Another option is L-girder benchwork, which is especially well suited for a

layout with curved sides or if you need a table longer than 12 or 14 feet (see Chapter 3 for details). We'll also look at plywood framework and tables made from hollow-core doors.

Frame table

Let's start with a simple grid-style table made from dimensional lumber, 2. Tables like this are sturdy, easy to build, offer good access for undertable wiring and switch machines, and provide floor space for storage.

A frame of 1 x 4s is more than solid enough to support scenery and trains in any scale. The table shown is designed for a 4 x 8-foot sheet of plywood. For smaller tables, use 1 x 3 lumber and 2 x 2 legs or choose one of the designs shown on pages 26 and 29.

You can see several types of benchwork joints in figure 3. The key with any butt-joint assembly, as with this table, is that the ends of the 1 x 4 joists, ends, and sides should be square. To do so, use a miter saw to make all of the cuts.

Assemble the framing to support the table, starting with the outer 1 x 4s. Drill countersunk pilot holes at the ends of each side 1 x 4, 4. Add glue to the end of an end piece, 5, and then use a cordless drill or driver to screw the side piece in

MATERIALS

Lumber

1 x 2, 8-foot, 4

1 x 4, 8-foot, 5

2 x 4, 8-foot, 2

1/2" plywood, 4 x 8 feet, 1

1/4" plywood, scraps for gussets

Hardware

1/4" x 3" carriage bolts, nuts, and washers, 4

No. 8 x 1 3/4" screws, 54

No. 8 x 1 1/4" screws, 12

No. 8 x 3/4" screws, 12

T nuts with threaded feet, 4

place, 6. I used 1 3/4" wood screws, but drywall screws will work as well. Repeat this process until you have the outer frame assembled.

Before adding the crosspieces (joists), check your track plan for any recessed areas. It's possible to do modifications later, but it's easier to adjust the interior framing now, if possible. Also, try to avoid having turnouts directly above joists, as the joists will interfere with undertable switch machines or mechanisms.

Mark the center of each joist along each side, 7. When adding joists, make sure that each is vertical by clamping a try square in place as a guide, 8. Glue and screw the ends of each. You can see the completed top frame in photo 9.

BASIC BENCHWORK JOINTS

Butt joint

Butt joints are weak because screws run into end grain. They are adequate when crosspieces form a grid.

Reinforced butt joint

A reinforced block can have one face glued and still be removable. Screws go through the block to hold one member and into the block to fasten the other.

Overlapping joint

The simplest overlapping joint uses a lengthened reinforcing block.

Large differences in height

A longer reinforcing block allows one member to be well above the other.

Cleated joint

A cleat, usually 1x1, serves as a holding device for parts that may be moved later, especially flat tops.

L-girder joint

When several crosspieces are attached, the L-girder joint is convenient.

Crutch block

A crutch block can hold a girder while assembling a frame without a helper, and it greatly increases the load that a joint can carry.

3

Legs

This table uses 2 x 4 legs, but 2 x 2s are generally more than sufficient for a 4 x 8 layout. I used 48"-tall legs, but you may want to choose a different height.

Since very few basement floors are level, it's good to provide a means of leveling the table once it's in place. An easy way to do this is by using T nuts and adjustable mounting feet, **10**, which are available at most larger hardware and home improvement stores. The mounting feet are also gentler on carpeted floors than is raw wood. If your floor is concrete, you can substitute inexpensive carriage bolts. Another option is using wheeled casters (see photo **31**).

Drill a hole in the bottom center of each leg to match the threaded rod of the mounting foot. Smaller T nuts have barbs that must be pounded in place with a hammer; larger ones like those in photo **10** have screw-mounting holes. Once the T nuts are installed, screw the feet in place.

Use a clamp to hold each leg in place. (You can also flip the frame upside down and install the legs one at a time.) Use a framing square to make sure the leg is perpendicular to the frame and then drill a $\frac{1}{4}$ " hole through



4 Drill three countersunk holes at the ends of each side 1 x 4 to attach the end pieces.

the side 1 x 4 and the leg for a carriage bolt, **11**. Push the bolt into place from outside the frame, add a washer and a nut, and tighten it with a wrench or ratchet.

Diagonal end braces made of 1 x 2s or furring strips will stabilize the table. Whenever you're designing or adding bracing, think in triangles. The exact locations for bracing aren't critical, but the lower the braces extend on the legs, the stronger the table will be.

Clamp a brace in place diagonally across one end and mark it to provide a guide for cutting, **12**. Cut the brace,

clamp it in place, check the leg with a framing square, and screw the brace in place with a drywall or wood screw, **13**. Photo **14** shows the table with the braces in place.

I used fairly short braces on the sides, which made the table quite solid but were unobtrusive enough to provide good undertable access for wiring and storage.

Cut the 1 x 2 side braces to fit, **15**. The top of each brace is screwed to the inside of the frame, with a gusset plate of $\frac{1}{4}$ " plywood attached to secure the braces to the legs. Clamp the gusset in

Layout height

Before building a layout of any type—tabletop or around-the-walls—you need to determine the layout's height. Layout height has been a subject of great debate in model railroading for years. The current trend is toward eye-level position of trains, giving the most realistic (ground-level) view. However, many modelers favor a lower height that allows viewing more of a scene and makes it easier to work on the layout.

Many factors enter into the layout height debate, including your height, the type of layout you're building (Midwestern plains or Rocky Mountains), whether you plan to operate your layout while standing or sitting, the height of your ceiling, and whether the layout has any significant grades.

Large walkaround-style layouts are generally built taller than table layouts because the operators are continually moving around the layout, following their trains while running them. For a small room or freestanding layout where operators are sitting, a lower height might be better. Although it's fun to watch trains at eye level, tall layouts can be awkward for operators if hand uncoupling tools or hand-thrown turnouts are used. Also, the taller the layout, the more difficult it is to reach in to work on scenery or fix any problems. If your layout is built on a continuous grade, you may have to start at a fairly low level in one area and continue to a tall height in order to keep the grade going. Consider all of the factors and choose a height that will work best for you.



Run a bead of yellow carpenter's glue on the end of the end piece before screwing it in place.



Screw the side to the end using drywall screws or 1 3/4" No. 8 wood screws.



Mark the location of the center of each crosswise joist on the top of each side member.



8

Clamp a try square in place to keep the joist aligned and then screw it into place.



9

The completed table frame is ready for legs and bracing.



10

Mark the center of the end of each leg, drill a clearance hole, and add the T nut and mounting foot.



11

Add a 1/4" bolt to secure each leg, tightening the nut securely with a wrench.

place and use wood or drywall screws to secure them.

Top

If you plan to elevate your track and scenery by using the cookie-cutter method or with risers and free-form subroadbed, you can continue with Chapters 4 and 5. If you just want a simple tabletop, read on.

The first temptation is to simply attach the plywood top by driving screws down through the top into the joists. However, this makes it nearly impossible to make changes once the track and scenery are in place. Attaching the top with cleats will make later alterations—including cutting and elevating the subroadbed and other features—much easier.

Add 1 x 1 or 1 x 2 cleats around the perimeter of the layout every 16" or so, and use one or two on each intermedi-

Leveling a layout

Regardless of how you build a table-style layout, it's important that the finished table be level to ensure good operation. You don't want rolling stock on supposedly level track to suddenly start rolling away. Check your layout with a level on both sides and ends when you get it into its final position. Adjust the feet on one or more legs as necessary until the table is level.



12

Clamp a 1 x 2 in place for the end brace and mark it for cutting.



13

Use a single 1 3/4" No. 8 wood screw to secure each end of the end braces.

ate joist, 16. Drill countersunk pilot holes vertically through the center of each cleat before installing it—a lesson I learned later.

Clamp each cleat in place, so the top is flush with the top of the joist. Use 1 1/4" wood or drywall screws (1 3/4" with 1 x 2s) to secure them.

Once the plywood top is in place, drive 1" coarse-thread drywall screws (1 1/4" if using 5/8" plywood) up through the cleats to anchor the table top, 17.

If you simply add screws from above, be sure to countersink the holes so that the screw heads don't interfere with track or other details, 18.

Larger tables

Although 4 x 8 is the most common size for a table like this, you can adjust the size to suit your needs. You can buy 1 x 4s in 10-, 12-, and 14-foot lengths (or you can splice two boards to make a longer one). Plans for 10- and 12-foot grid tables are shown in figure 19.

Notice how all tables longer than 8 feet have the legs set in from the ends; if there's more than 24" of overhang on the ends, add braces from the legs to the ends.

I wouldn't recommend building a grid table longer than 12 feet. A better choice for long tables is the L-girder design shown in the next chapter, which allows building single tables up to 20 feet long with just four legs.

Smaller tables can follow the same design as the table on page 19. For tables 4 x 6 feet and smaller, you can substitute 1 x 3s for the frame.



14

The end braces are in place and the table is nearly complete.



15

Cut the lower end of each side brace at a 45 degree angle to match the legs. Screw a 1/4" plywood gusset plate in place to secure the brace and leg.



16

Clamp cleats made from 1 x 2s or 1 x 1s in place and secure each with two screws.



17

Secure the plywood top by driving screws upward through each cleat.



18

If you use any screws on top of the table, be sure to countersink the holes so that the screw heads are recessed.



20

This 4 x 8-foot table was made entirely of plywood except for the molding-strip X-bracing.

Plywood framing

A popular alternative to using dimensional lumber is framing the benchwork with strips of plywood. Finding straight dimensional lumber can be a challenge, and buying select or No. 1 boards can be expensive.

Two advantages of using plywood strips are dimensional stability—plywood won't expand or contract as much as individual boards—and consistent quality, as strips cut from plywood won't warp or twist. You can also save some money, as you can get 12 or 13 8-foot-long, 3½"-wide strips from one 4 x 8-foot sheet of plywood.

Disadvantages are that you'll need to have a table saw or circular saw to cut the plywood, and the process takes time and a bit of work. Doing this might be daunting for a basement-sized empire, but it's quite doable for a table layout.

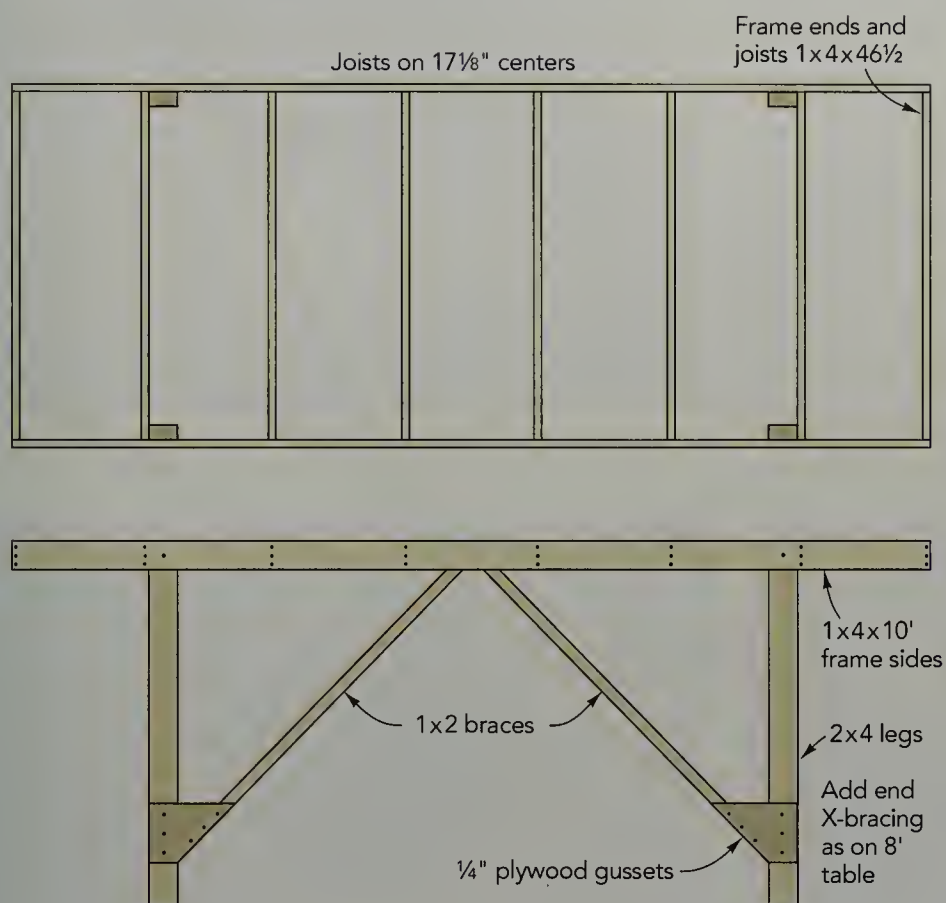
The benchwork for *Model Railroader's* 4 x 8 Rock Ridge Central project layout was built this way, 20, as was MR's Black River Junction project layout, 21. Jim Hediger chose ½" birch plywood. It's a bit more expensive than fir, but has seven plies (instead of five) and is stronger than fir.

This layout is also 4 x 8, but has a 1'-6" x 6'-0" extension off one end. The extension is removable, held in alignment by dowel locating pins. The extension's legs and braces are secured by bolts and wing nuts, and the tops of the legs are curved to allow them to be folded up into the extension frame-work when the extension is removed. You can, of course, build an extension similar to this one but as a permanent addition.

This design can easily be adjusted for a smaller layout or—with a larger sheet of plywood—a larger layout.

Jim used a table saw to cut the plywood into strips. If you don't have a table saw, do as I did and cut it with a circular saw, 22. Place the plywood on sawhorses with a few lengthwise 1 x 4s to support it. Measure the distance from the edge of the saw frame to the inside edge of the blade (4½" for the saw shown). Mark the location of the cut at each end of the plywood: 3½" from the side. Clamp a straight 1 x 4 or 1 x 3 to the plywood to serve as a rip fence for the saw, 23. To match the saw width, the edge of my 1 x 4 had to be 4½" from the mark. The fence will then guide the saw smoothly along the plywood, 24. Repeat the process to cut the remaining strips.

10-FOOT GRID TABLE



MATERIALS

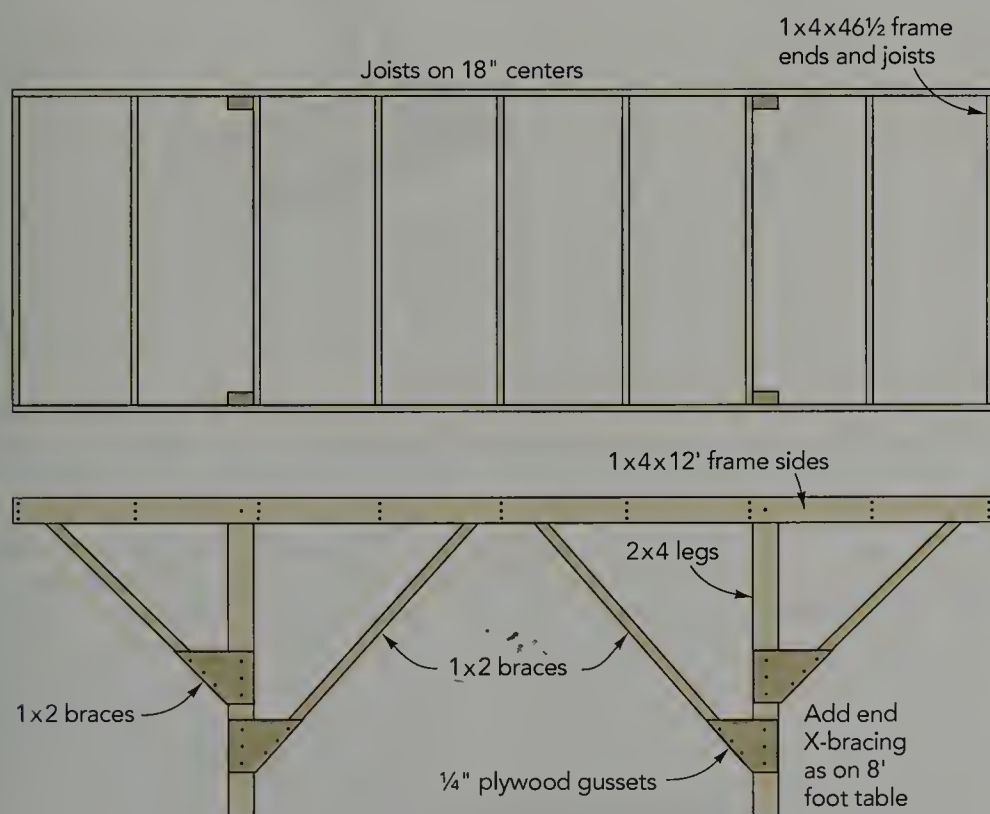
Lumber

1 x 2, 8-foot, 8
1 x 4, 10-foot, 2
1 x 4, 8-foot, 4
1/2" plywood, 4 x 8 feet, 1
1/2" plywood, 2 x 4 feet, 1
1/4" plywood, scraps for gussets

Hardware

1/4" x 3" carriage bolts, nuts, and washers, 4
No. 8 x 1 3/4" screws, 56
No. 8 x 1 1/4" screws, 16
No. 8 x 3/4" screws, 12
T nuts with threaded feet, 4

12-FOOT GRID TABLE



MATERIALS

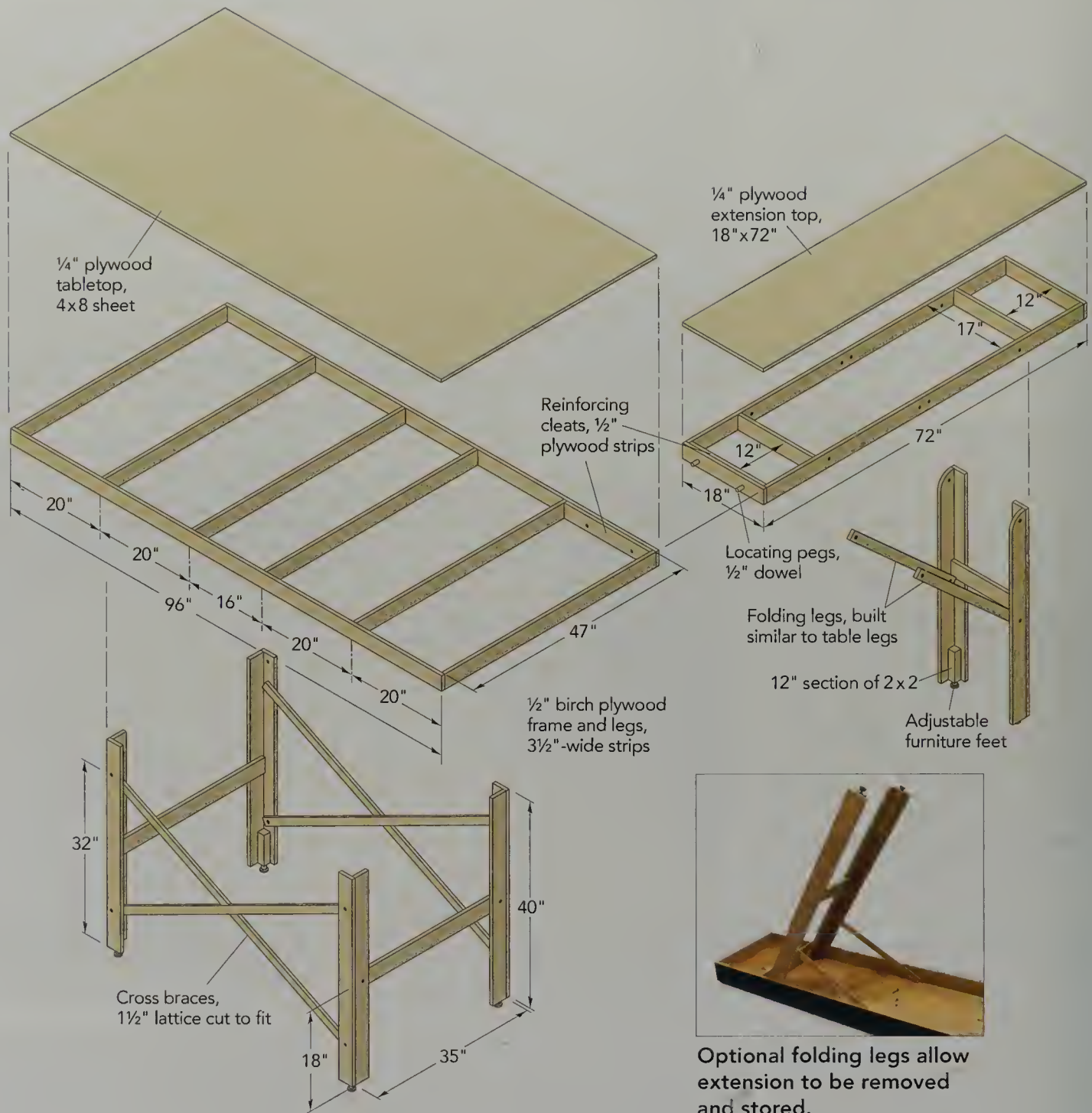
Lumber

1 x 2, 8-foot, 8
1 x 4, 12-foot, 2
1 x 4, 8-foot, 5
1/2" plywood, 4 x 8 feet, 1
1/2" plywood, 4 x 4 feet, 1
1/4" plywood, scraps for gussets

Hardware

1/4" x 3" carriage bolts, nuts, and washers, 4
No. 8 x 1 3/4" screws, 62
No. 8 x 1 1/4" screws, 32
No. 8 x 3/4" screws, 24
T nuts with threaded feet, 4

ALL-PLYWOOD TABLE



21

Give each cut edge a quick pass or two with a sanding block and medium-grit sanding paper. This will knock down any rough edges and help prevent splinters later.

The frame joints are put together with wood glue and 4d (4 penny) finishing nails, 25. Screws would be overkill for the plywood, and would risk splitting open the ends of the strips. Start the nails in each corner piece and then add glue. Gently tap the nails in place while making sure the joint stays in alignment. Add the interior cross-pieces in the same manner, 26.

Legs

The legs are Ls of the same plywood strips. Cut the strips to the desired leg length (the layout shown used 40" legs). Run glue along one edge of a strip and clamp the second strip on top, 27. Tack the strip in place with several 4d finishing nails.

To make the legs adjustable, glue and screw a length of 2 x 2 into the L at the base of each leg, 28. This can protrude from the base of the L, or it can be flush. The length of the 2 x 2 isn't critical but make sure at least 6" rests in the L. Add a T nut and adjustable foot as in the table in photo 10.

Tack the plywood top in place on the frame temporarily, just to make sure it stays square, and flip it upside down. Add the legs, inseting each 6" toward the middle of the inside cross member, 29. For strength (and to make them removable), use 1/4" carriage bolts to secure the legs to the frame.

Add the bracing. Attach the straight pieces across each end (plywood strip), using a pair of 3/4" screws on each end of a strip. Add the diagonal braces on each side with a screw at each end. This bracing can be simple 1/4" x 1 1/4" plain molding or 1 1/2" lattice. As you add each



22

Before cutting the plywood, measure the distance from the edge of the blade to the edge of the saw.



23

Clamp or screw a straight 1 x 4 in place to serve as a rip fence for the handheld circular saw.



24

Guide the saw smoothly along the 1 x 4, and the result will be a smooth cut and a straight plywood strip.



25

Glue the end of the crosspiece and tack the side piece in place with 4d finishing nails.

piece, use a carpenter's square to make sure the legs remain perpendicular to the frame.

Flip the table back upright with the help of a partner. You can leave the plywood in place if you just want a flat tabletop, or you can use the cookie-cutter or other techniques to add grade and scenery variations as Chapter 5 explains.

Small rolling layout

Putting a small layout on wheels or casters makes a lot of sense. It allows you to move a layout for photography or maintenance. It can also allow a layout to share a rec room or basement area designed for other activities.

The 2 x 8-foot table in photo 30 was designed to support one piece of *Model Railroader's* multisection HO scale Beer Line project layout. The table would work well on its own for an N scale layout or for a small HO switching layout, or the design could be

expanded up to a 4-foot width as a stand-alone layout.

Because it's designed to be moved (rolled), a strong, square frame is vital. The parts are all shown in photo 31. Assemble the 1 x 4 tabletop frame as with the earlier tables in this chapter, using wood glue and 1/4" drywall screws to secure each butt joint.

Add the plywood top (simply tacking it in place if you plan to later cut away areas, as with cookie-cutter roadbed), and flip the frame upside down on the floor or a large table.

The legs are Ls, made in similar fashion to the earlier plywood table but by gluing a 1 x 2 on edge to a 1 x 3 and securing it with drywall screws. Glue a 12" length of 2 x 2 in the bottom corner of each leg to provide a solid base for the casters.

The 1 1/2" casters shown are serviceable for smooth, hard surfaces (such as a concrete basement floor). However, if your layout will be on an uneven surface or a carpeted floor, use 2" (or larger)

high-capacity casters. For installation, some casters simply require drilling a hole to match a mounting peg; others have a mounting bracket that must be screwed into place.

Add the legs, securing them to the interior frame corners, 31. You can glue and screw them in place for a permanent installation or bolt them in place if you want the top to be removable.

Add the remaining 1 x 2 braces, gluing and screwing each in place. The angle braces are each 12" long, with 45 degree angles cut in each end with a miter saw. The lengthwise 1 x 2 brace helps stabilize the benchwork, keeping everything square as the table is pushed or pulled when rolling it.

You can use the same design up to 4 x 8 feet. Use the same framing spacing as the layout shown on page 19, and inset the legs 6"-8" from each side. Larger (and heavier) layouts will require heavier, larger casters.

Layouts on casters can be difficult to level. Several types of leveling casters



26

The completed frame is ready for the table top and legs.



27

Make each leg by gluing two plywood strips to form an L. Clamp the pieces and use finishing nails to secure them.



28

Add a T nut and leveling foot to each leg as shown on page 22.



29

It's easiest to add the legs and bracing with the table flipped upside down. Inset each leg 6" from the side.

are made, along with casters that can be retracted onto solid feet, which allow leveling. These cost more but will make moving and setting up a layout much easier.

Hollow-core door tables

A popular choice for a small table layout is an inexpensive hollow-core interior door, 32. Benchwork tables made in this manner are inexpensive, lightweight, and quite strong. They can be built with permanent legs or be made portable by using removable or folding legs. The door itself is sturdy and won't twist, so no additional framework is needed.

These doors are typically 6'-8", 7' or 8' long and come in widths from 24" to 36". This pretty much limits this method to N scale, but it can also work for a small switching or display layout in HO or larger scales.

When buying a door, look for the least expensive one, since you won't be seeing the finish. You might be able to save a few bucks by asking if there are any slightly damaged doors hiding in the storeroom.

To make a door-style table portable, add folding legs to the bottom, 33. The ones shown (many styles are made) can be found at hardware and home centers. You can buy these new, or you might be able to salvage a pair from an old folding table.

Photos 33 and 35 show the basic construction. These doors consist of thin sheets of lauan plywood attached to a narrow wood frame, with a honeycomb paper interior. Other than the

frame around the edges there's nothing solid to them, so you can't anchor screws anywhere but the edge of the door.

Cut 1 x 4s to match the width of the door and anchor them with two screws at each end, making sure the screws are driven into the frame. Anchor the legs to these 1 x 4s. Specific mounting dimensions will vary by type and brand of legs—mount the legs so they are set in roughly one-fifth of the table length from the ends.

Some folding legs are rather short by model railroad standards. The legs on this table have been extended by adding lengths of conduit piping over them, 34. Once the conduit is in place, drill a pilot hole in it and drive a sheet-metal screw through the conduit into the leg.

Add a 4" length of wood dowel to the bottom of each leg, driving it in place to a force fit in the conduit. Anchor it with a screw through the conduit at the top of the dowel. You can then add a T nut and a bolt or adjustable foot to the bottom of the leg, 35.

The table is then ready for a model railroad, 36. Once the table itself is complete, paint the surface to seal it and prevent any damage from water-based scenery. As the photo shows, you can also glue a piece of 1½" or 2" foam board to the table as a base for the layout.

Table on bookcase

Another handy option for a table layout base is a prefab bookcase, 37. The bookcase in the photo measures 12" x 28" and is 44" tall. These easy-to-assemble kits are offered at most home center and office supply stores.

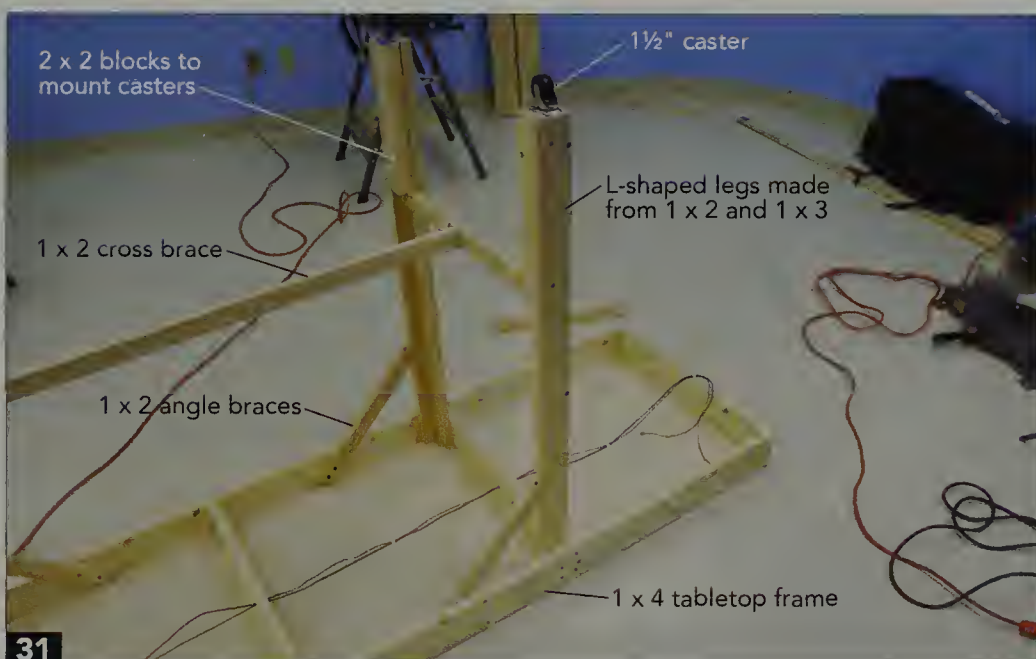
A single bookcase can support a hollow-core door up to 36" as figure 38 shows. The top doesn't have to be anchored to the bookcase. Simply glue lengths of 2 x 2 to the underside of the door to fit around the perimeter of the bookcase top. The door can then be lifted off the bookcase. You'll need to be careful to not locate track feeders, other wiring, or undertable switch machines directly over the bookcase.

Multiple bookcases can also support a grid-style table, 38. You can hold the grid in place in the same manner as the door, or you can anchor them with L-shaped metal anchors, 39. Make sure that no more than one-fifth of the table's length or width hangs over any side or end.



30

This section of an HO layout is built on a 2 x 8-foot rolling table. The table could easily be used as a stand-alone layout.



31

This view shows most of the benchwork construction, including frame, legs, and bracing. All joints are secured with glue and screws.



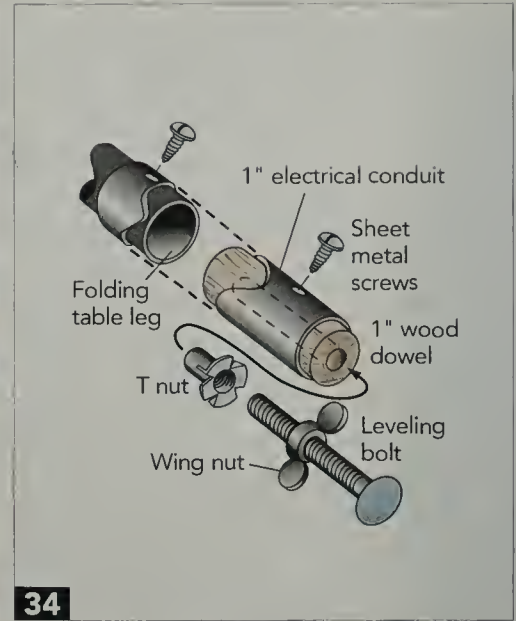
32

A hollow-core door is an excellent layout base, especially for N scale layouts. The foam top can be cut away to provide variations in elevation.



33

A pair of 1 x 4s, secured by glue and screws into the door's outer frame, provide a solid base for folding legs.



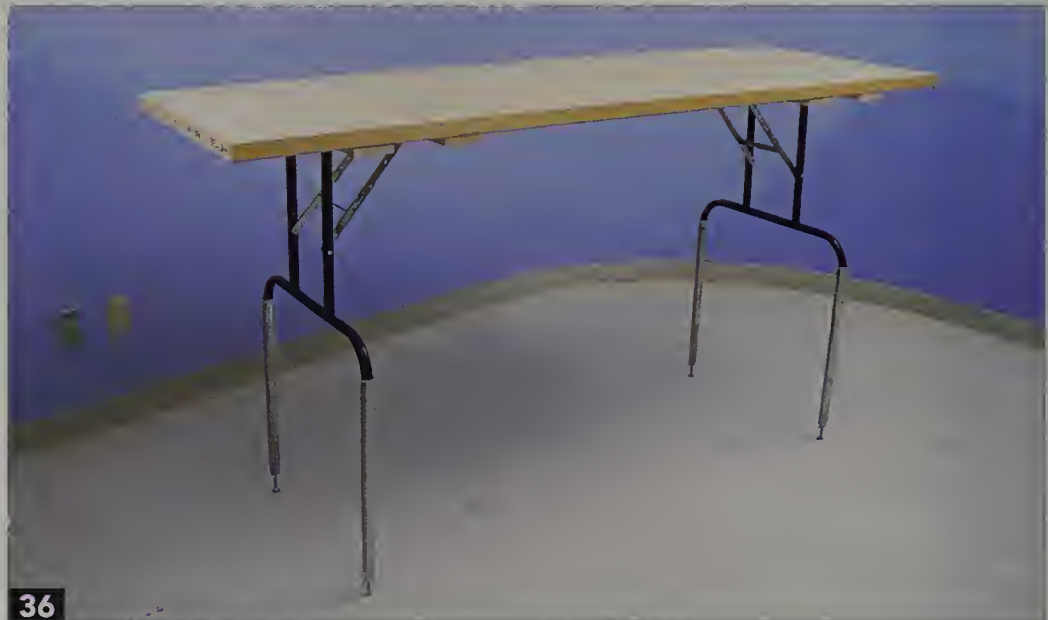
34

Lengths of conduit serve as leg extensions.



35

Dowels inserted in the ends of the conduit hold the adjustable feet securely.



36

The finished table is ready for scenery and track.



37

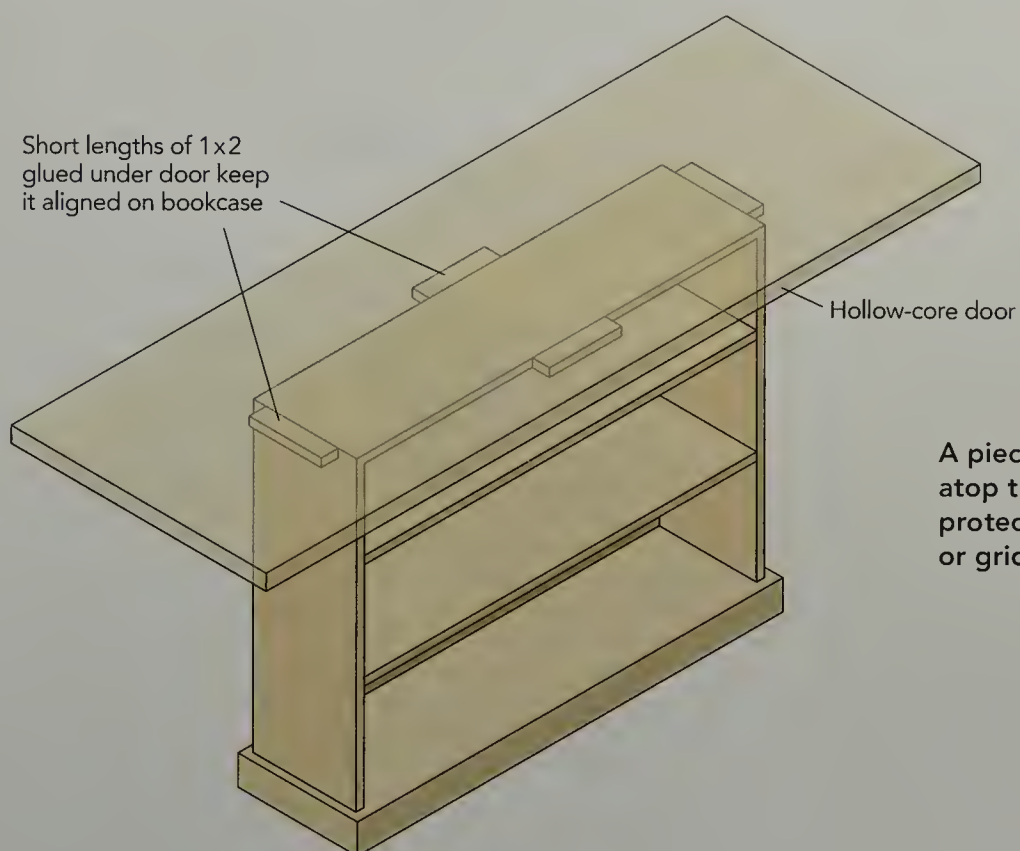
A bookcase can hold a stand-alone layout or a section of a larger model railroad, as with this HO layout.



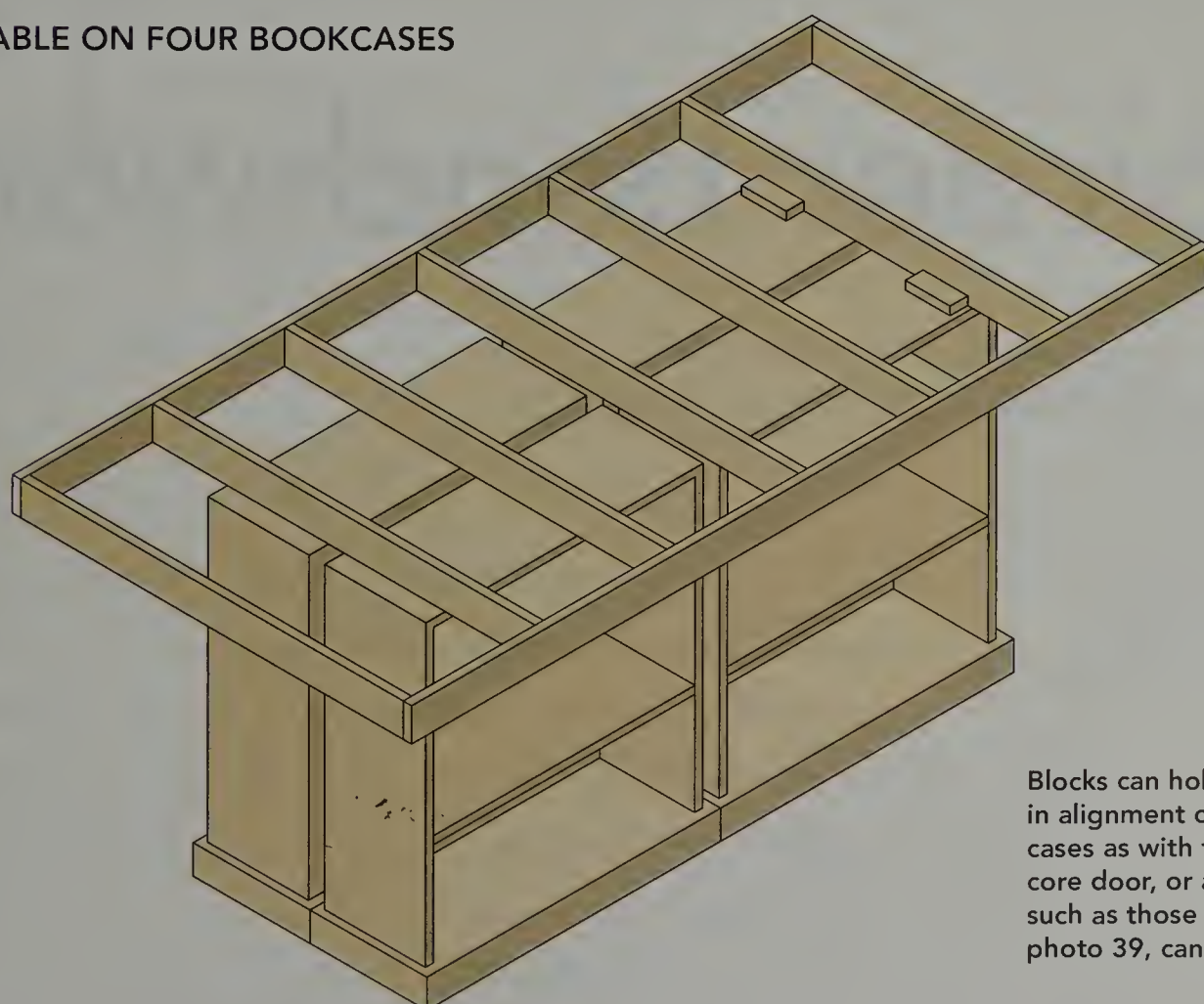
39

A small L-shaped anchor can be screwed to the grid and bookcase.

HOLLOW-CORE DOOR ON BOOKCASE



GRID TABLE ON FOUR BOOKCASES





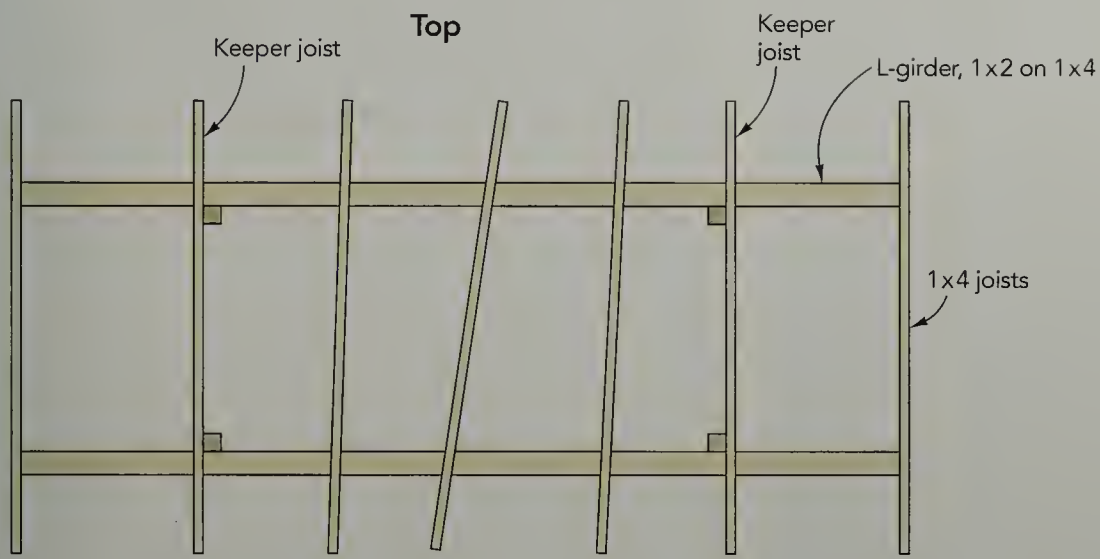
L-girder benchwork

A versatile base for larger layouts

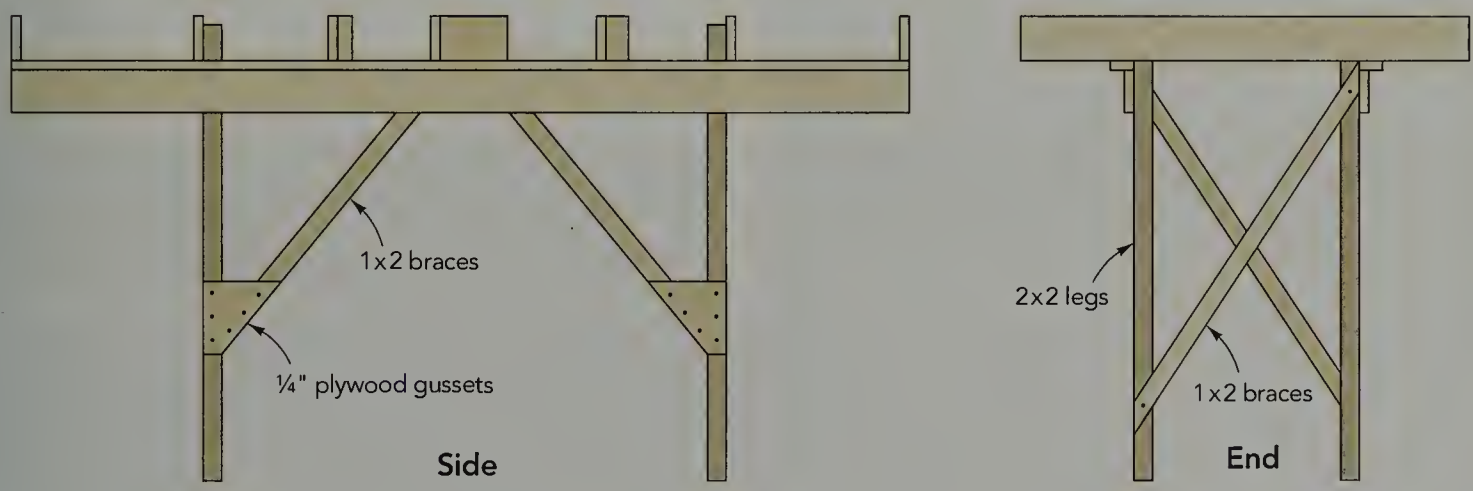
L-girder benchwork is a viable choice for tables like this one as well as room- and basement-sized empires.

Developed by former *Model Railroader* editor Linn Westcott in the 1950s, L-girder benchwork quickly became popular for good reason. It's sturdy, easy and quick to assemble, and economical in wood use. It works for tables, **1**, or complex-shaped model railroads, and it can support long spans (up to 22 feet) with just four legs.

BASIC L-GIRDER FRAMEWORK

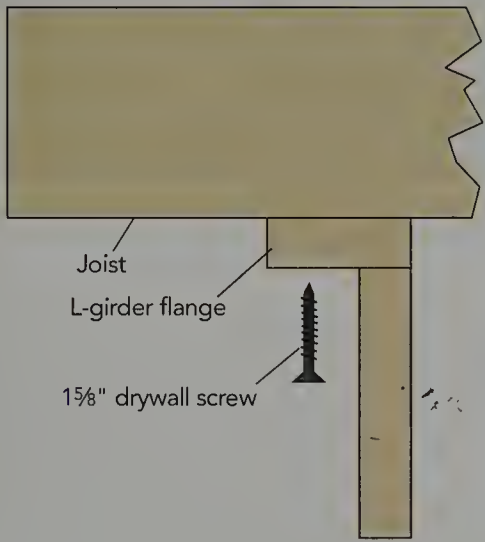


Joists (other than keepers) may be placed at angles



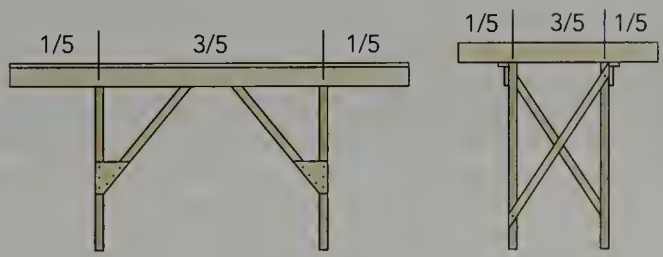
2

L GIRDER CROSS SECTION



3

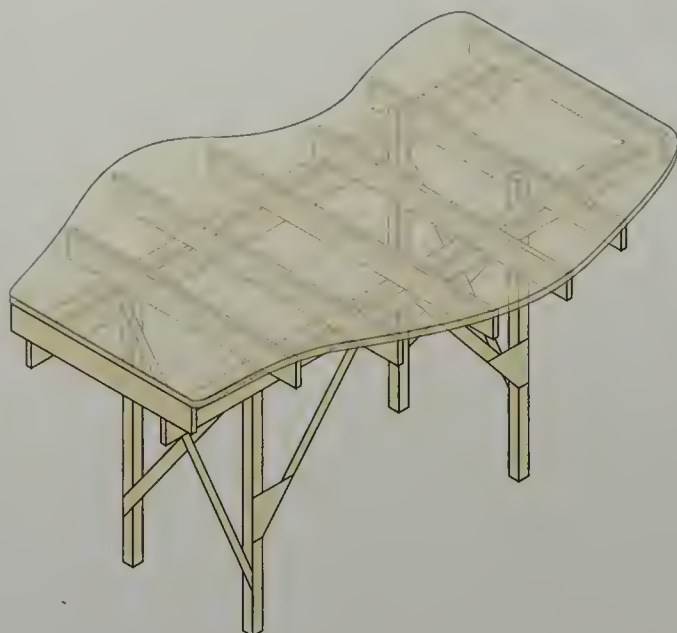
CALCULATING GIRDER SPANS



- 1x2 = Up to 10' length
- 1x3 = Up to 14' length
- 1x4 = Up to 22' length

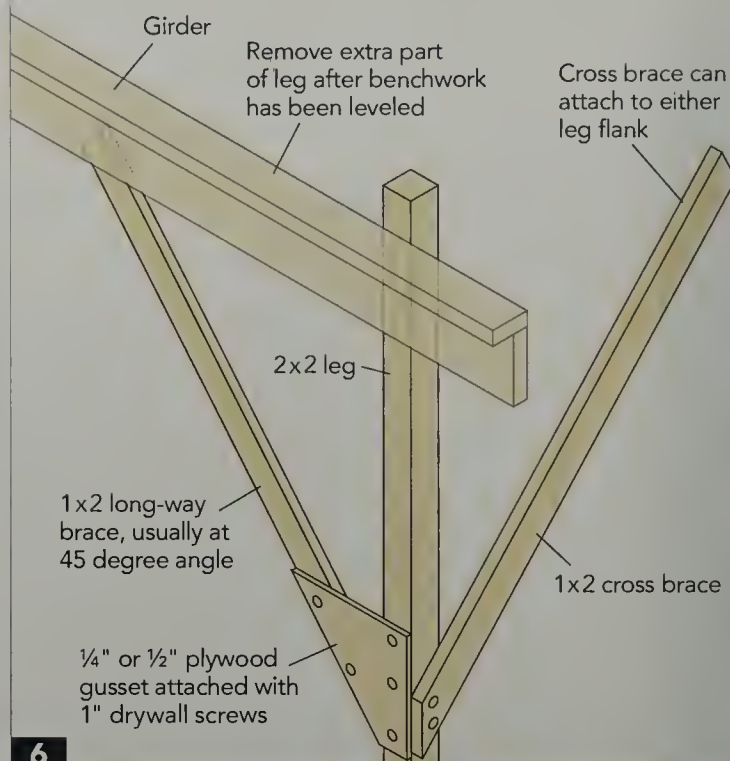
4

FREE-FORM LAYOUT ON L-GIRDER FRAME

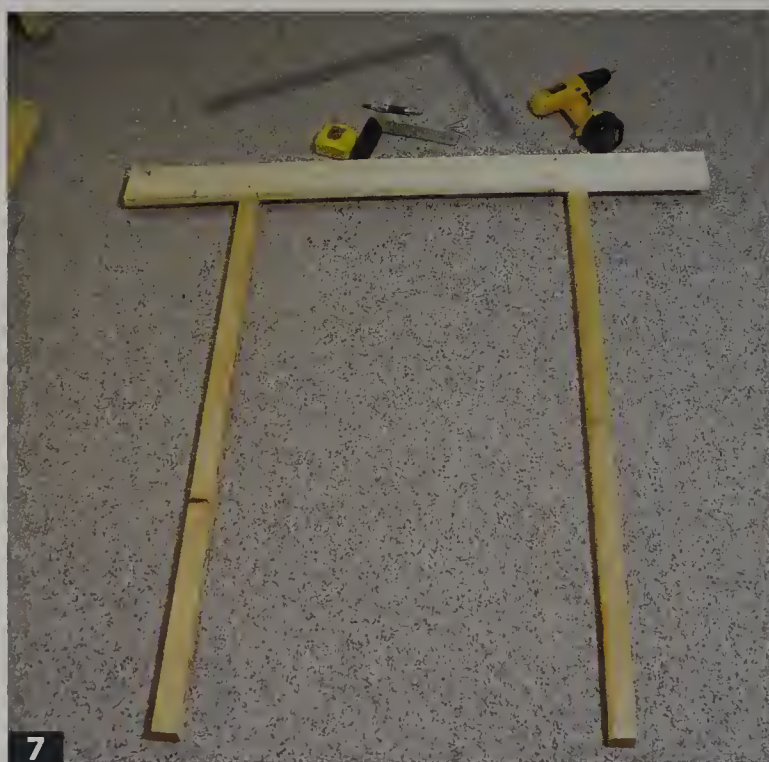


5

TYPICAL SINGLE LEG ASSEMBLY

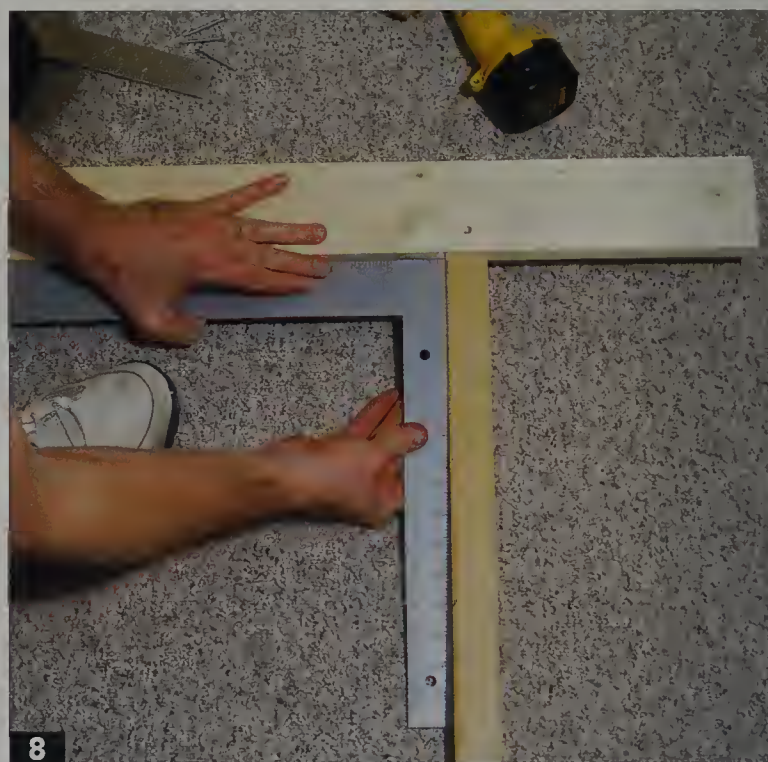


6



7

Begin by positioning a joist atop a pair of legs. Each leg should be set in one-fifth the length of the joist.



8

Add one screw and then check the leg with a square before adding the second screw.

The heart of the design is the girder itself, made by fastening a 1 x 2 flange atop a piece of 1 x 2, 1 x 3, or 1 x 4. Figure 2 shows the framework of a basic table. The L-girder design is an excellent choice for long table-style layouts as well as around-the-walls model railroads, and it can be adapted to wall-mounted benchwork as Chapter 6 shows. The principles remain the same, and complex layouts

are a matter of connecting sections of benchwork together.

The flange gives the girders remarkable strength and also allows you to add joists at any location by means of screws driven into the joists from the bottom of the flange, 3.

The joists can be used to support a plain tabletop, a cookie-cutter top, or free-flowing subroadbed on risers, as explained in Chapter 5. The L-girder de-

sign has great flexibility, as the joists can easily be positioned at any convenient location and at any angle to allow for rivers, roads, towns, and other elements.

When designing an L-girder layout, the most critical dimensions are fifths, 4. The leg assemblies should each be set in one-fifth of the total length, and the girders should be set in one-fifth the length of the joists (although some joists may overhang farther than this, 5).



9 Add the first diagonal brace and then flip the assembly over and add the second brace.



10 One leg assembly is complete and ready for the girders.



11 Spread glue on the top of the girder (in this case a 1 x 4) and then clamp the 1 x 2 flange on top. Secure the flange with drywall or wood screws every 12" or so.



12 Clamp the girders to the completed leg assemblies.

Many modelers automatically use 1 x 3s or 1 x 4s for the girders, but 1 x 2s are strong enough for spans up to 10 feet and 1 x 3s up to 14 feet. With sufficient bracing, 2 x 2s are more than adequate for legs, 6. It's important to attach the leg bracing close to the floor (usually 9" to 12" from the floor), especially for long spans and tall layouts.

Construction tips
Start by making the leg assemblies. I didn't do it on this layout, but I highly recommend adding adjustable mounting feet to the bottom of each leg as shown in Chapter 2. Doing so will make it much easier to level the table if the floor isn't quite level (and few floors are). Measure and mark a spot one-fifth of the way in from each end of the joist

(9½" for a 4-foot-wide layout). Set the legs in relation to these marks so that the top of each leg is just shy of the top of the joist, 7. Add one drywall or wood screw to hold each leg in place, 8. Use a framing square to make sure that each leg is square with the joist and then add a second screw to secure each leg. Add the first diagonal brace. Cut



13

Make sure the legs are square to the girders before screwing or bolting them into place.

each end of the brace using a miter saw and then use a single screw at each end to secure it, 9. Before adding the screw at the base of the each leg, check the leg once again with the square. Flip the assembly over and add the second diagonal brace on the other side of the legs. Photo 10 shows the finished leg assembly.

When selecting lumber for L-girder layouts, be sure to choose the straightest boards possible for the girders and flanges. Begin making an L girder by running a bead of carpenter's glue along the top of the vertical girder and then use several clamps to hold the flange in place, 11. Use 1 $\frac{3}{4}$ " drywall or wood screws to attach the flange.

Once the girders are made, clamp them to the leg assemblies, 12. Make



14

Clamp the plywood gusset plate in place and use screws to secure the plate to the leg and brace.



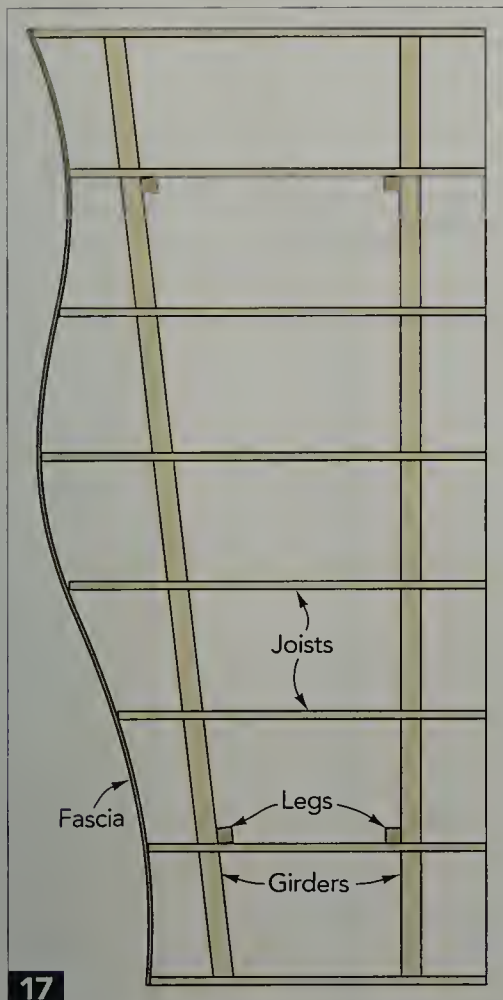
15

Use a pair of screws to secure the top of each brace to the inside of the girder.



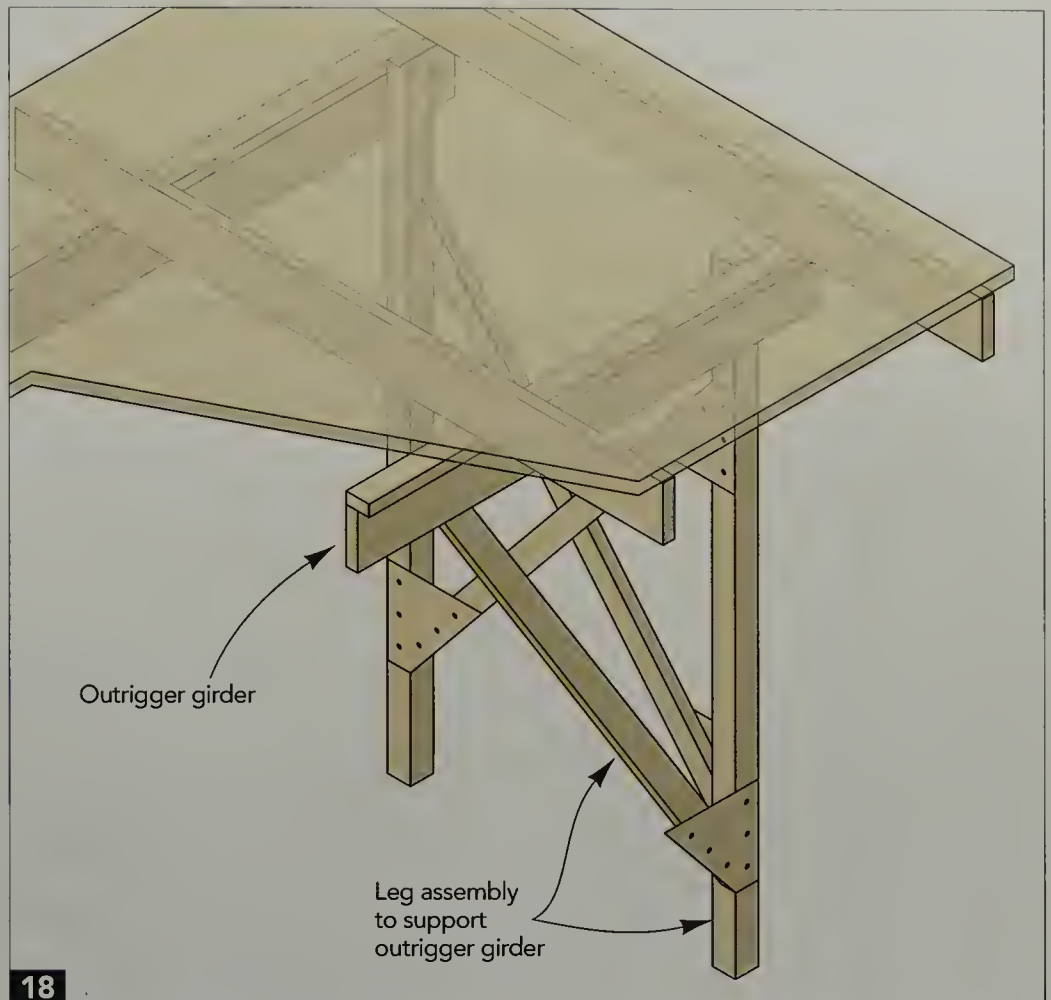
16

Fasten the joists by driving a screw through the underside of the girder flange into the joist.



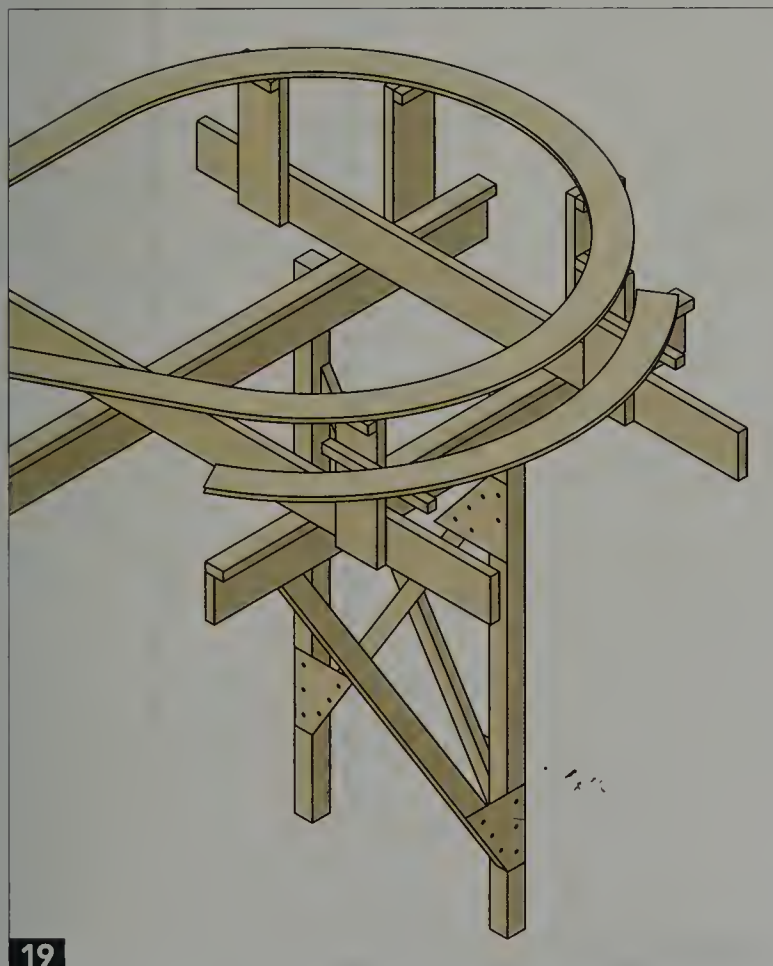
17

L-girder benchwork is ideal for layouts with uneven sides or dimensions.



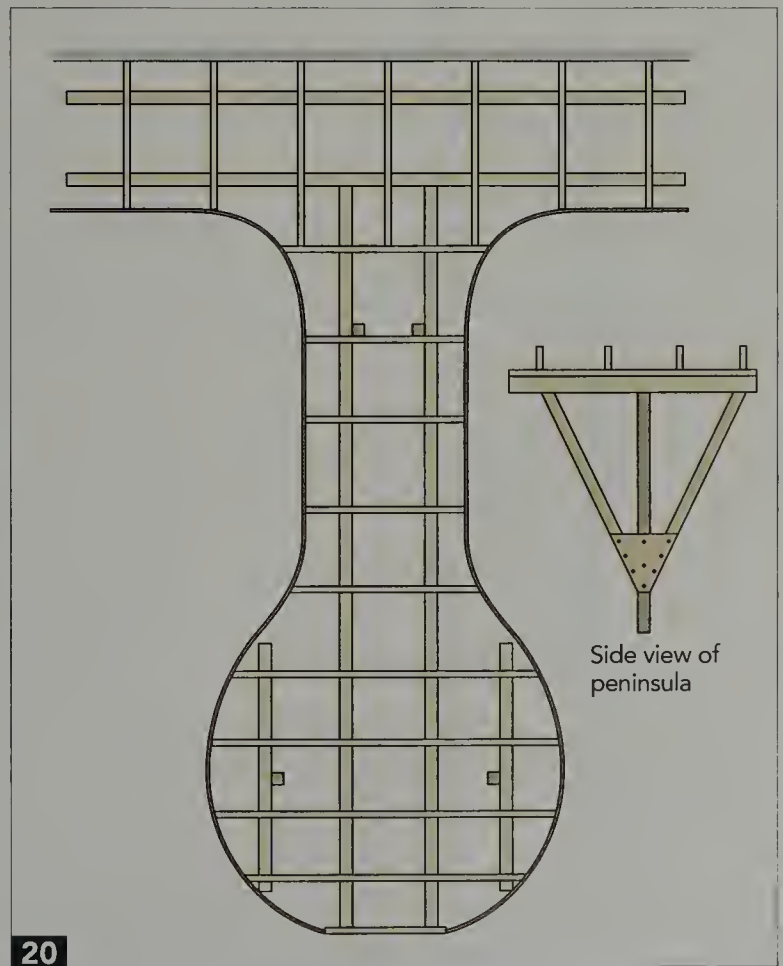
18

An outrigger girder, leg, and brace can support an extension at the end of a layout or table.



19

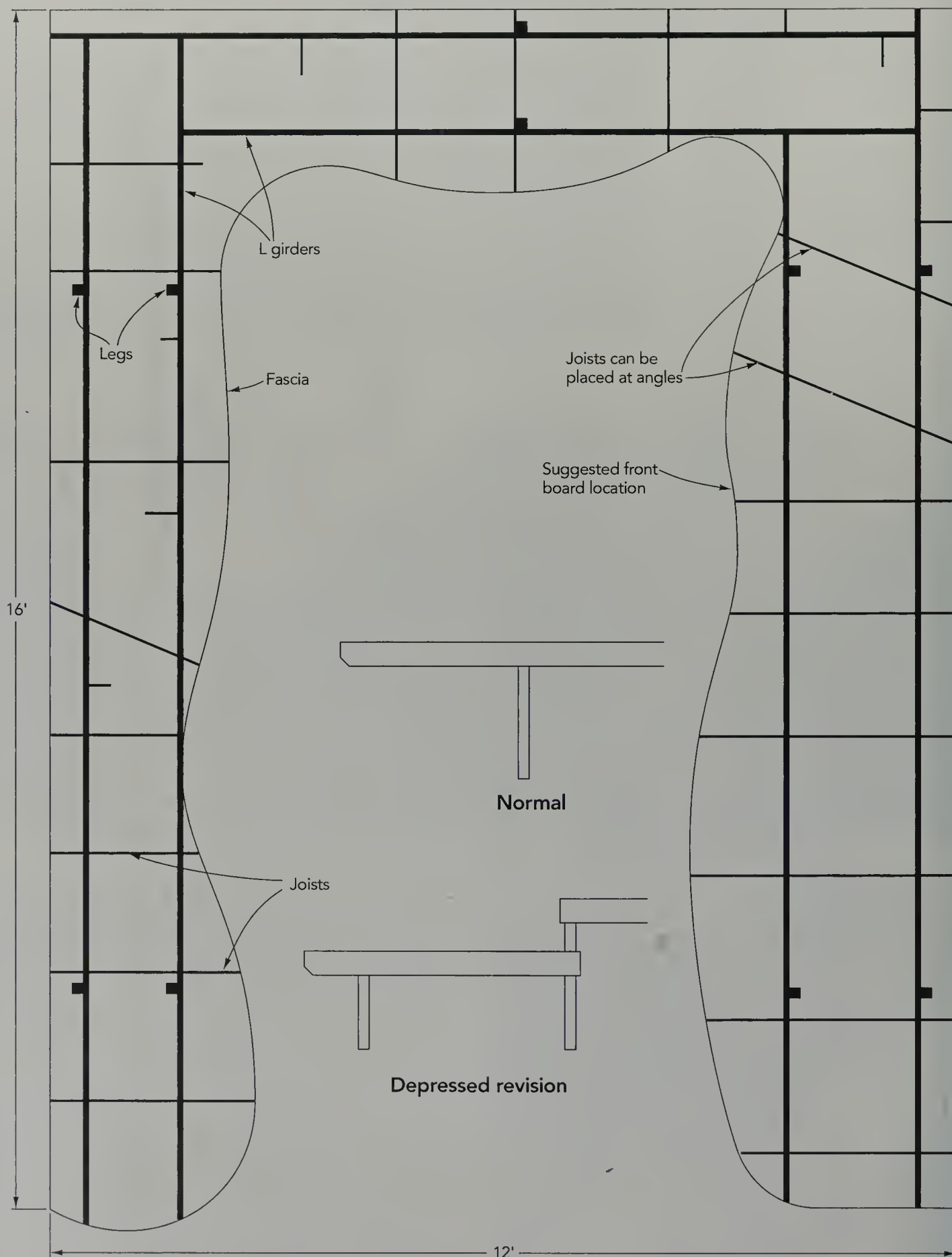
A turnback curve or other feature can be supported on joists with a long overhang. This view shows free-form subroadbed.



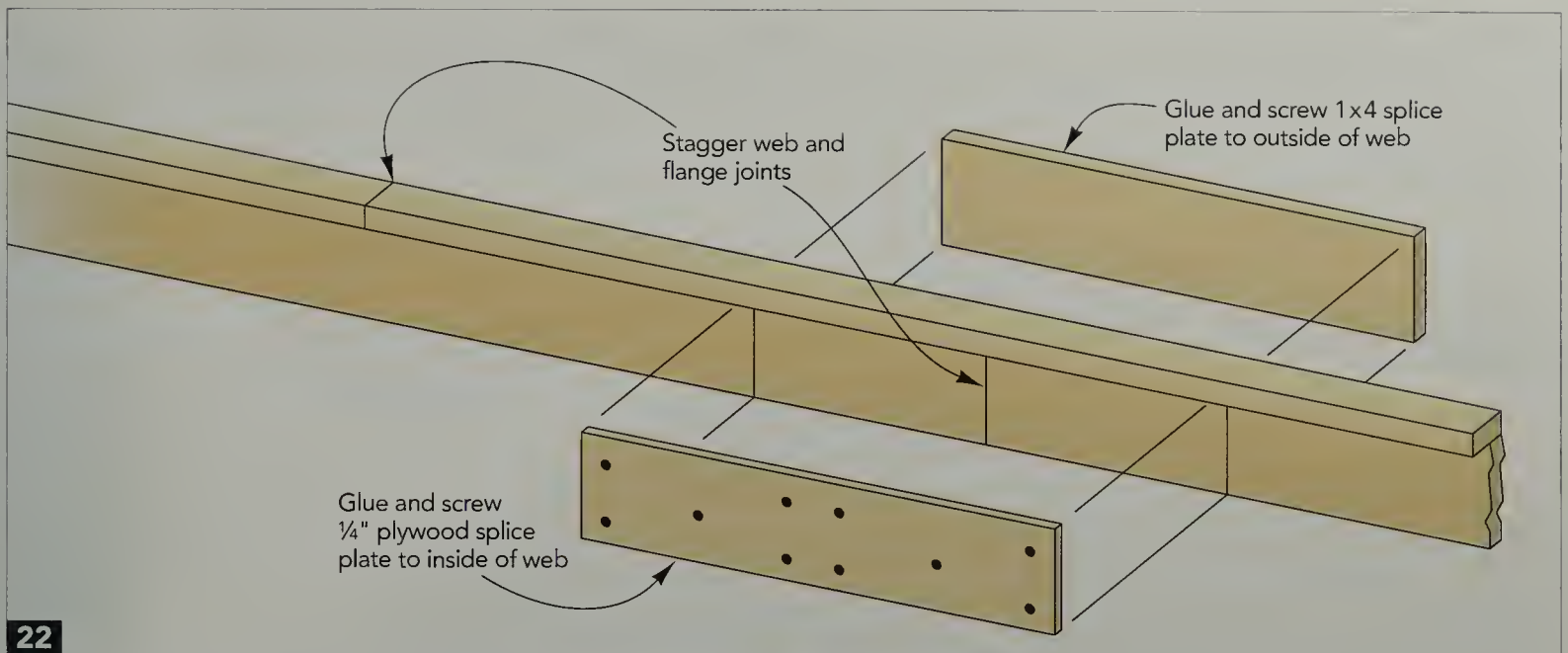
20

A peninsula or other extension can be added by butting L girders into girders of the main layout section or table.

FRAMING FOR AROUND-THE-WALLS LAYOUT



The figure shows L girder and joist locations for a 12 x 16-foot around-the-walls layout. The design takes advantage of the long spans allowed by L girders.



22

Girders can be spliced for layout sections and tables longer than 8 feet.

sure that the girders are level with each other. Drive a 2" No. 8 wood screw through the girder into each leg and then use the framing square again to make sure the legs are square to the girders before adding a second screw, 13. You could also use a single $\frac{1}{4}$ " carriage bolt if you prefer.

Add the side diagonal braces. These can be 1 x 2s, furring strips, or plain molding. Use $\frac{1}{4}$ " plywood gusset plates, 14, to secure the bottoms of the braces to the legs. A pair of screws anchors each brace inside the joist, 15. The table itself is now complete.

All that's left is adding the cross-wise joists. If you're building a simple tabletop, you can secure the joists now; if you're using a cookie-cutter or open style, then don't screw the joists in place yet. Instead, wait until you know where track and complex scenic details will be located. An advantage of L-girder construction is that joists can be placed at angles (as in figure 2) if needed.

To anchor joists, drill a pilot hole and drive a screw through the flange into the bottom of the joist, 16. Make sure you have support for the top or roadbed every 16" or closer. By anchoring the joists from below, they can be moved at any time—for example, if you later discover that a switch machine is located directly above one.

The keeper joist can be left in position, or it can now be removed and moved if needed—it has served its purpose of keeping the table aligned through construction. If you move it, cut off the legs flush with the top of the girder.

You're now ready to add the tabletop or subroadbed. See Chapter 5 for details on free-form subroadbed and cookie-cutter tables.

Larger layouts

Building a room-filling—or basement-sized—layout with L-girder benchwork follows the same designs as the basic table. You can adjust the length and width to fit almost any situation—the construction steps remain the same.

One strength of L-girder construction is that it can be used to design odd-shaped areas. Since there's no outside frame, joists can be different lengths, so if you want the layout wider or narrower at an area—to accommodate an aisle, for example—you can cut joists longer or shorter, 17.

Some joists can overhang their girder by more than one-fifth their total length, but if you have several that need to be longer (or single ones overhanging more than half) it's wise to build an outrigger assembly, 18. This is also handy for building short perpendicular extensions at the ends of tables.

Making the end of a table wide for a turnback curve is another option, 19. In both of these examples, the joists will later be hidden by fascia, as described in Chapter 8.

Peninsulas can be added by butting a pair of L girders to the outside girder of the main benchwork, 20. That drawing also shows how the end of the peninsula can be made wider than the main body of the peninsula.

An example of designing L-girder benchwork for an around-the-walls layout is shown in figure 21. The black outline shows how the fascia (outside edge of the layout) can easily be curved by using joists of varying lengths. Note how several joists are placed at angles, which can accommodate variations to scenery such as rivers and valleys, and how 10 legs are sufficient for supporting the entire layout.

Splicing girders

When you're building tables or layout sections longer than 8 feet, it is necessary to splice the L girders to make longer pieces. You can buy 1 x 4s up to 14 feet long, but they can be difficult to find (and tough to transport).

When splicing a girder, stagger the joints on the flange and web, 22. It's not necessary to add a splice plate on the flange, just the web. Add a 1 x 4 plate on the outside of the L (or 1 x 3 or 1 x 2 to match the girder). The length of the plate should be at least four times the depth of the web. Glue it in place and use four or five screws on each side of the joint.

Glue and screw a splice plate of $\frac{1}{4}$ " plywood on the inside of the L. This adds stability to the joint and still allows room for driving screws through the flange into joists above the splice plates.

Chapter 5 shows how to add subroadbed to L-girder and other types of benchwork, and Chapter 6 presents some examples of using L girders with wall-mounted benchwork.



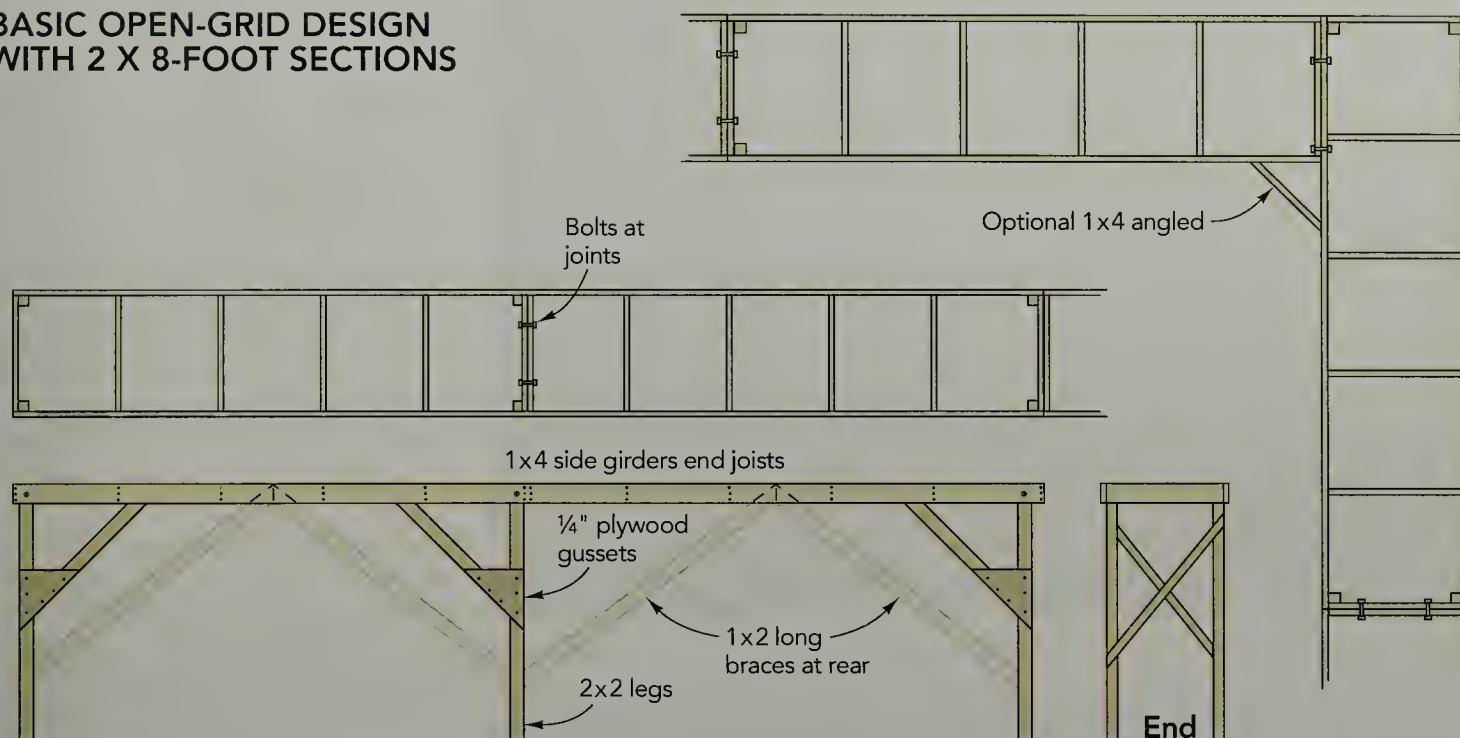
Open-grid benchwork

Expanding benchwork around a room

Sections of open-grid benchwork (also known as butt-joint) can be assembled to create layouts of all shapes and sizes.

Open-grid benchwork is excellent for linear around-the walls layouts and is also adaptable to odd-shaped areas, **1**. When you're designing a layout, a good way to look at open-grid benchwork is as a series of interconnected boxes, each of which can be rectangular, square, or odd shaped. Linking the boxes provides a solid base for a layout. The method is very versatile—once the grid is together, subroadbed, roads, rivers, and other elements can be added at various levels above and below the frame.

BASIC OPEN-GRID DESIGN WITH 2 X 8-FOOT SECTIONS



2

Freestanding benchwork works well in basements where it would be difficult or undesirable to anchor a layout to a concrete wall. It's also good for use in finished rooms or areas if you don't want to mar the surface of existing walls. Freestanding benchwork is solid and will still allow a great deal of open space below the layout for wiring access and storage. (See Chapter 6 for details on wall-mounted grid benchwork.)

Open-grid construction follows the same construction methods as the simple grid table shown in Chapter 2. Building a larger layout is a matter of expanding beyond a single table by adding a series of additional tables, each connecting to another, 2. Each grid section can be almost any size, but the practical limit on length is 8 feet. Longer tables would require additional legs or inset legs, as shown in Chapter 2. When designing a layout, don't make tables any wider than a comfortable reach. If you're tall and have a medium to fairly short layout (48" or under), 24" to 30" is within reason; taller layouts greatly reduce the length of your reach.

Basic construction

It's important to use straight lumber, as any twists in boards will throw off the squareness of the frames. I prefer 1 x 4s for the frame with 2 x 2 legs and 1 x 2s (or furring strips) for bracing.



3 The first section is complete. The longer braces can be kept at the rear, providing better storage and undertable access from the front.

Start in one corner with the first frame and then work outward from there. Make the grid itself in the same way as the frame for the table in Chapter 2 is done. Assemble the outside box of the frame and then add the crosswise joists. Glue each joint and secure them with 1 1/4" drywall or wood screws. Add the legs and the end cross bracing. The completed first grid table is shown in photo 3.

Note how the lengthwise bracing is longer at the rear than the front. This

provides a strong table and gives you better undertable access for wiring and storage.

The small front diagonal bracing helps provide lateral stability, and most of it will be later covered by fascia (more on that in Chapter 8). You could eliminate this bracing on tables 24" and narrower: just check the tables for stability as you assemble the benchwork.

If you're planning to add a backdrop—which I recommend (see Chapter 8)—you'll want to do the prep work for it as



you build the grid tables. Adding a backdrop after the track and scenery are in place is difficult and frustrating.

Regardless of the material you choose for the backdrop, you'll need to provide solid support for it. Vertical 1 x 2s (sometimes combined with horizontal 1 x 2s as Chapter 8 shows) will work with most types of backdrops. I added 1 x 2s mounted every 48" along the rear of the benchwork. Add one mounting screw and then check with a level before adding a second screw, 4. The height of the vertical supports will vary depending upon the height of your layout and ceiling.

Next, add the second grid table to the first. You need only two legs, since the first grid will support one end of the second. Clamp the two together to get proper alignment, 5, and then drill 1/4" holes through the abutting end

4 Add backdrop supports before placing layout sections in place against walls. Clamp the 1 x 2 in place and add a screw (at left). Clamp a level in place to ensure that the support is vertical before adding the second screw (at right).



5 Make sure the two sections are aligned at the top of the grid and then drill holes for the bolts to connect the sections.



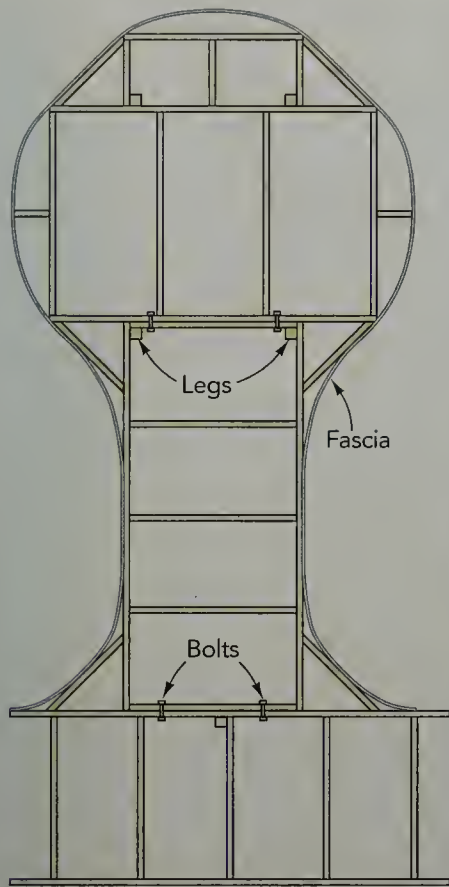
6 Add a bolt with washers and a nut in each hole. A ratchet makes quick work of tightening the nuts.



7 Run a 1 x 2 or furring strip brace from the rear leg of the first table to the midpoint of the second grid.



8 At the corners, a diagonal brace from the rear leg up to the inside joint stabilizes the corner.



10

Adding a peninsula is just a matter of combining multiple grid sections.

pieces. Slip 2" x 1/4" carriage or hex bolts through the holes to attach the sections, 6. Two bolts are sufficient for narrow joining faces (30" or less); use a bolt at each end and every 18" or so for wider faces.

Add a long brace from the rear leg of the first table to the midpoint of the second frame, 7, and add cross bracing to the two legs of the second grid. Locking several grids together like this will result in a very strong, sturdy layout.

Figure 2 shows how to join two grids in a corner. After bolting them together and adding the long rear brace, add a 45 degree brace from the leg to the grid by the inside corner, 8. This will keep the inside corner from sagging.

Adding a peninsula is similar. Bolt the first grid of the peninsula to the grid of the main layout, 9. If this junction is near the middle of the main layout grid, you may have to add a single leg, as shown in the photo.

Figure 10 shows how you can combine multiple grids to make a peninsula, including a wide end to provide for a turnback curve. Note that you're not limited to square corners. Adding 1 x 4 fillers at grid joints makes the benchwork flow more smoothly and



9

Add a leg for support when adding a peninsula at the middle of another table.



11

Give a layout more usable space at inside corners by adding a 1 x 4 at an angle.



12

Miter the 1 x 4 ends and drill pilot holes in each end to help guide the screws into position.



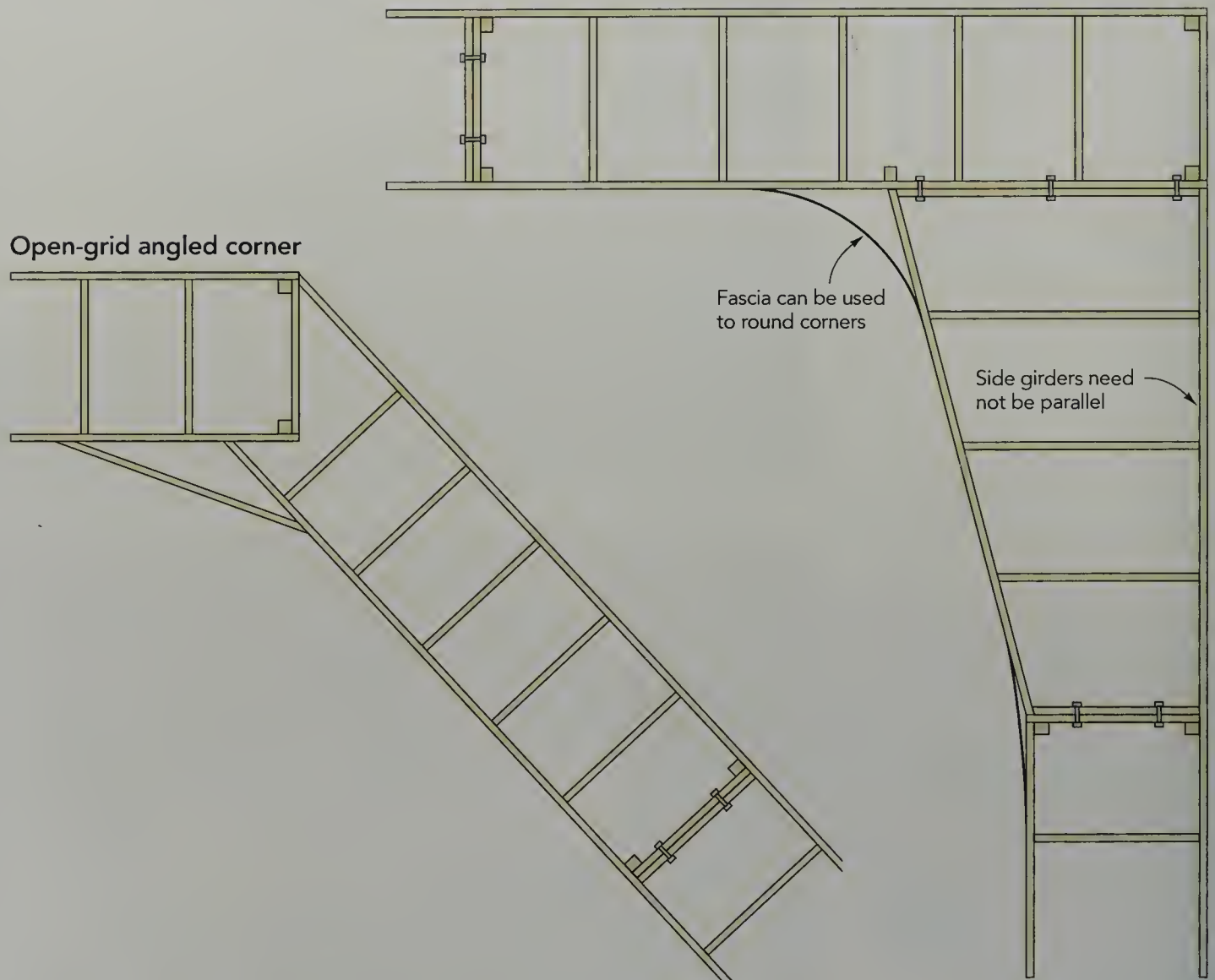
13

The angle will provide support for the fascia and result in a smooth curve at the corner.

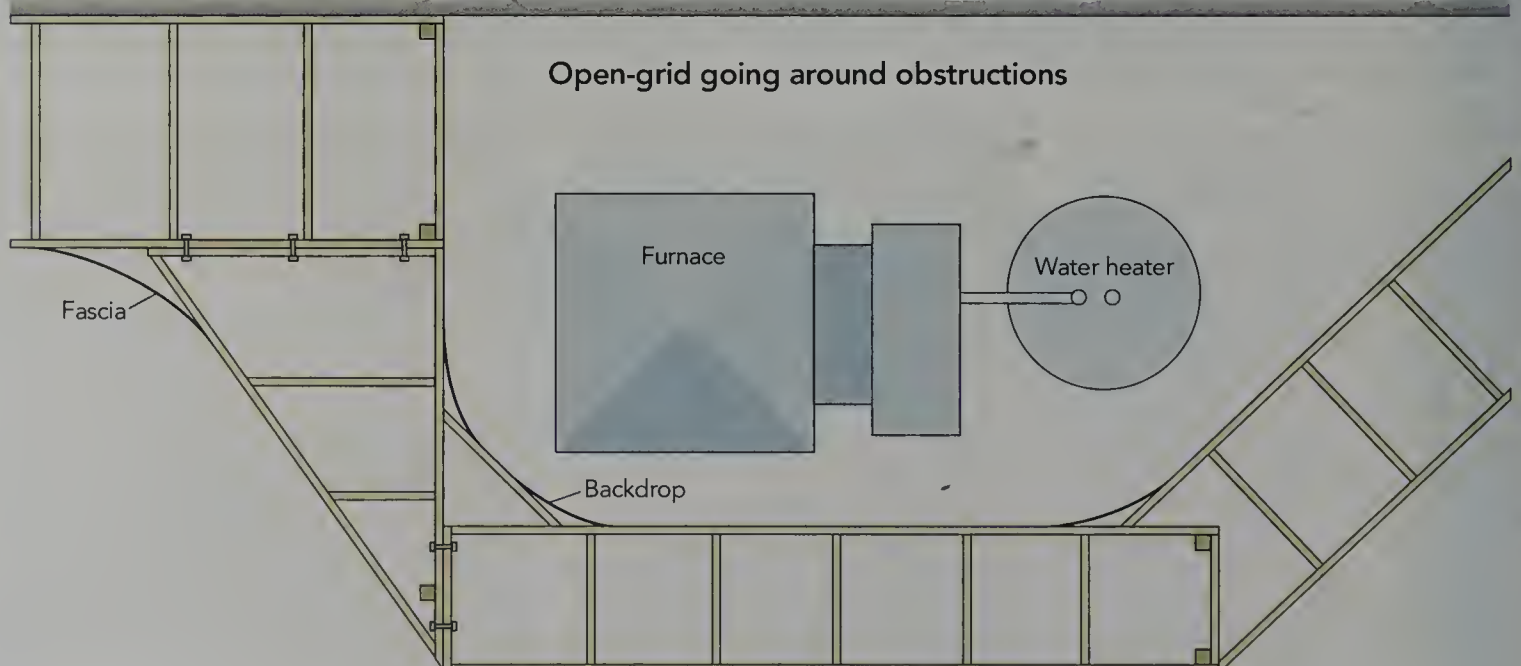
CORNERS AT ODD ANGLES

Open-grid odd shapes

Open-grid angled corner



Open-grid going around obstructions



Prefabricated benchwork



Prefabricated benchwork is an option for modelers who either aren't comfortable with cutting and fitting their own benchwork or who can't do it because of location (such as apartment dwellers who aren't allowed to use power tools).

Available from companies including Mianne (www.miannebenchwork.com) and Sievers (www.sieversbenchwork.com), prefab benchwork includes precut components that make assembly quite easy

and result in strong, good-looking benchwork. No cutting of lumber is necessary, and parts go together with mechanical connectors (no glue required). Both companies have extensive websites that detail the products and services available.

Kalmbach's *Classic Toy Trains* magazine staff built the layout shown above with Mianne benchwork, modifying it only by adding casters to the legs to make it easier to move.



N scale Ntrak modules must follow certain specifications—such as having three main tracks—but the scenery and other details can vary widely. The standards allow multiple modules to be combined for operation at shows and meets.

adds valuable space to the layout. Cut a 1 x 4 with ends mitered at 45 degrees and clamp it in place, 11. Drill pilot holes in each end, 12, and screw them in place, 13.

It's easy to then round these corners later using fascia (Chapter 8). You're not limited to 45 degree angles—Figure 14 show how these can be used

with grids of various shapes and sizes. Note how side girders need not be parallel (a miter saw is vital in cutting these odd-angled joists). The figure also show how you can get around furnaces and other obstacles. Doing this is just a matter of putting the grid pieces together and using some creativity.

Modular and sectional benchwork

Layouts built in modules and sections generally use some form of grid or butt-joint design. Although modular and sectional layouts are both designed to be moved, it's important to know that there's a difference: modular and sectional are not the

Access hatches



Although not designed as an access panel, this removable scene illustrates a great way to make one. Start by framing an opening. Note the wooden stops partially in the opening that keep the cattle pen (on a piece of plywood) from falling through. *David Haines*

It's best to avoid deep shelves or wide areas of benchwork that leave track out of reach of an aisle. However, if you wind up with such an area, you'll need to provide access to that area. The most common way to do this is with a hidden access panel.

As with liftout track sections (Chapter 9), it's best to keep access panels as simple as possible. The photos show one way of doing this. Start by framing an opening in your benchwork and cutting a panel (a piece of plywood is fine) that drops into place. When building scenery, continue the scenery across the access panel. The size can vary, but make

sure the opening is large enough to fit through to do routine maintenance (such as cleaning track and scenery or rerailing trains).

The photos also show how a cattle pen fits into an opening on David Haines' N scale layout. Although David didn't design this as an access panel (he wanted a scene that could be easily changed), it's a perfect illustration of how to build one (although it would need to be larger). For an access panel, it's generally easier to keep the scenery rather plain on the panel to avoid the risk of damaging extensive modeling work.



Ray and Renee Grosser built their beautiful HO scale Soo Line layout in sections to enable them to take it to shows across the country. Ray built a rack designed specifically to store and transport the sections.

same thing, and the terms aren't interchangeable.

Modular means that each section is built to the same overall specifications, so each can be swapped or interchanged with another one. For

example, a 4-foot Ntrak module can be taken out of a layout, and virtually any other one can be substituted in its place, 15.

Sectional means that a layout can be disassembled into pieces, but each sec-

tion is not necessarily interchangeable with the others. Each section may be a different shape and size with varying track arrangements, 16.

Modular and sectional model railroading have grown in popularity since

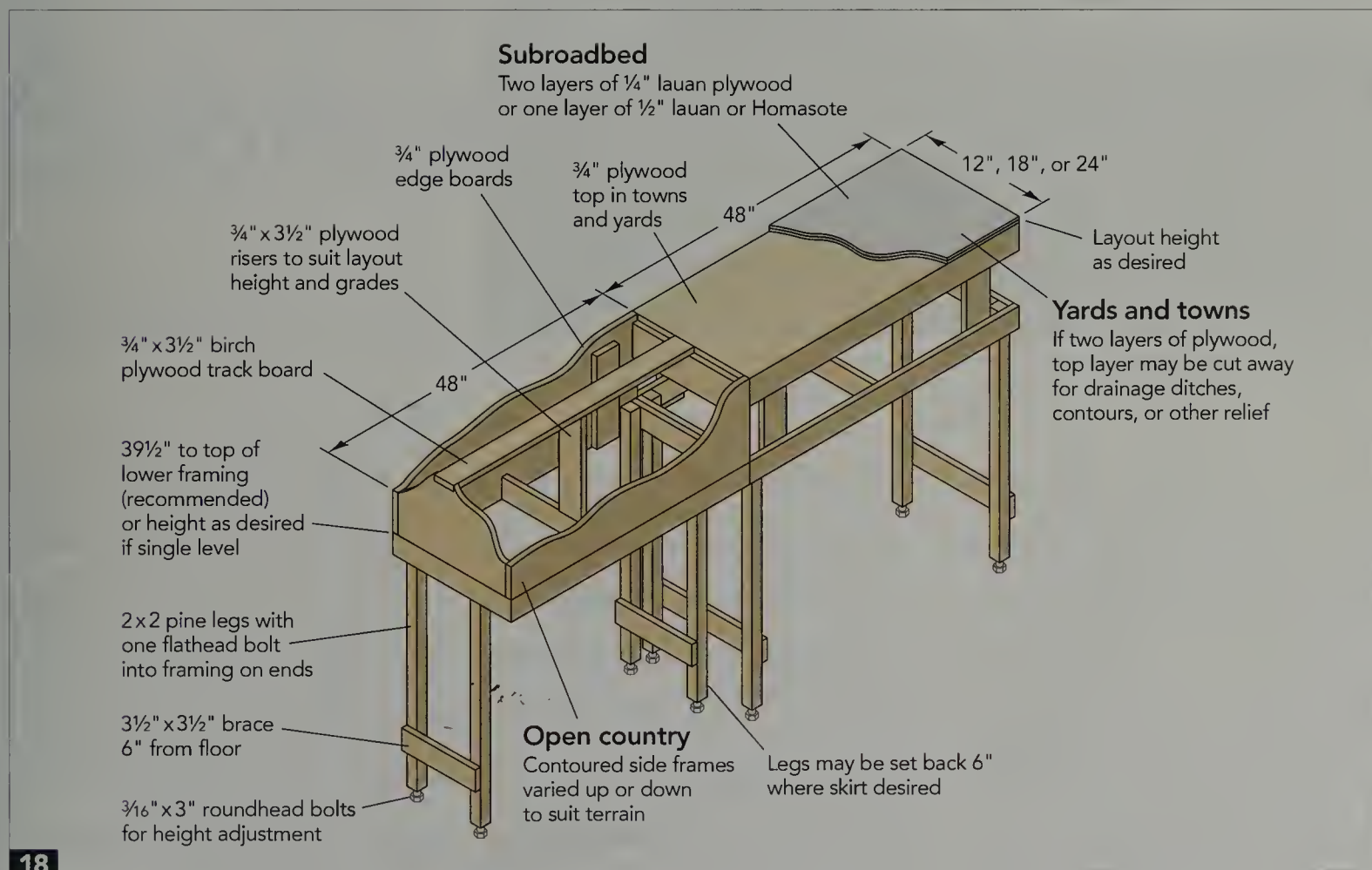
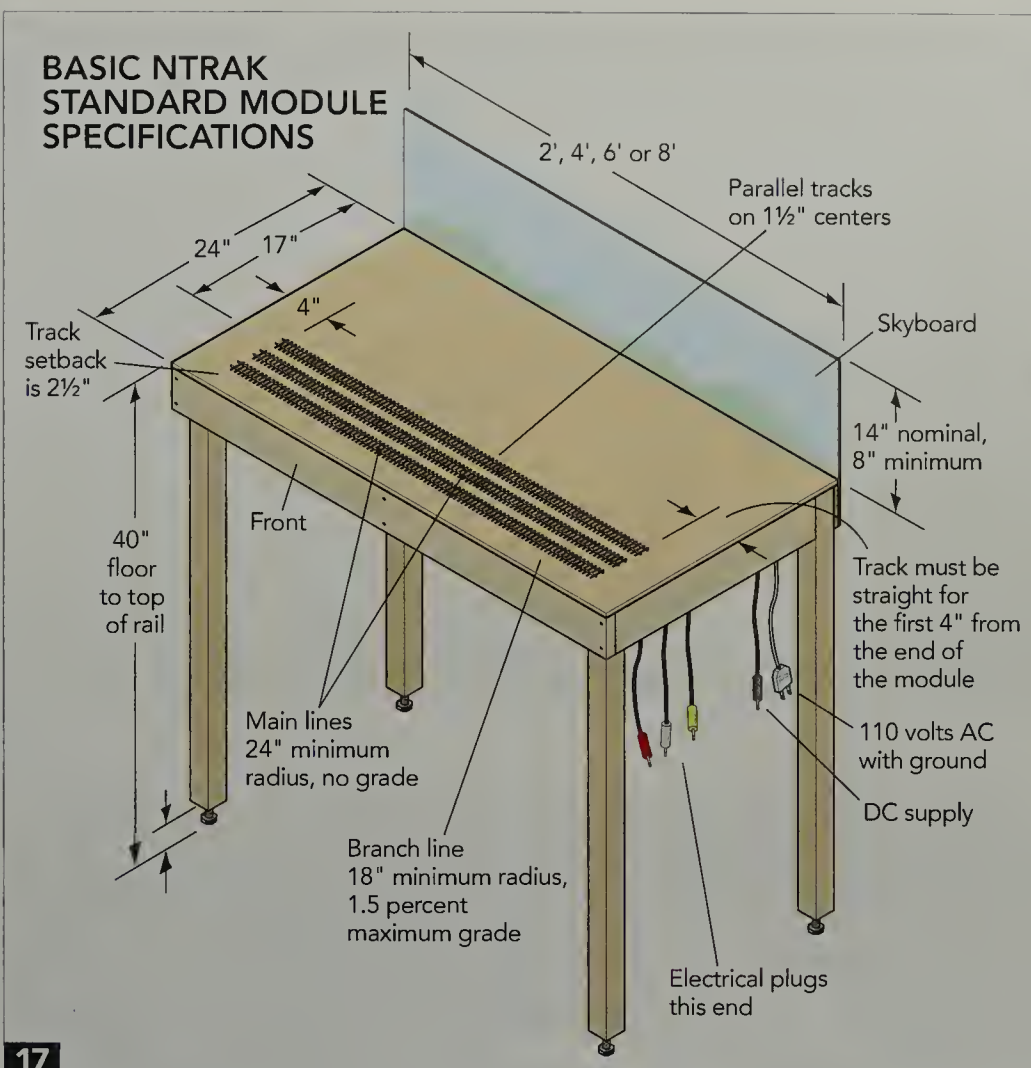
the 1970s. The driving force in modular design has been Ntrak, the group that has established widely accepted standards for N scale. For home and club layouts, sectional construction can offer some advantages over permanent benchwork. Let's look at modules first.

Modular model railroading

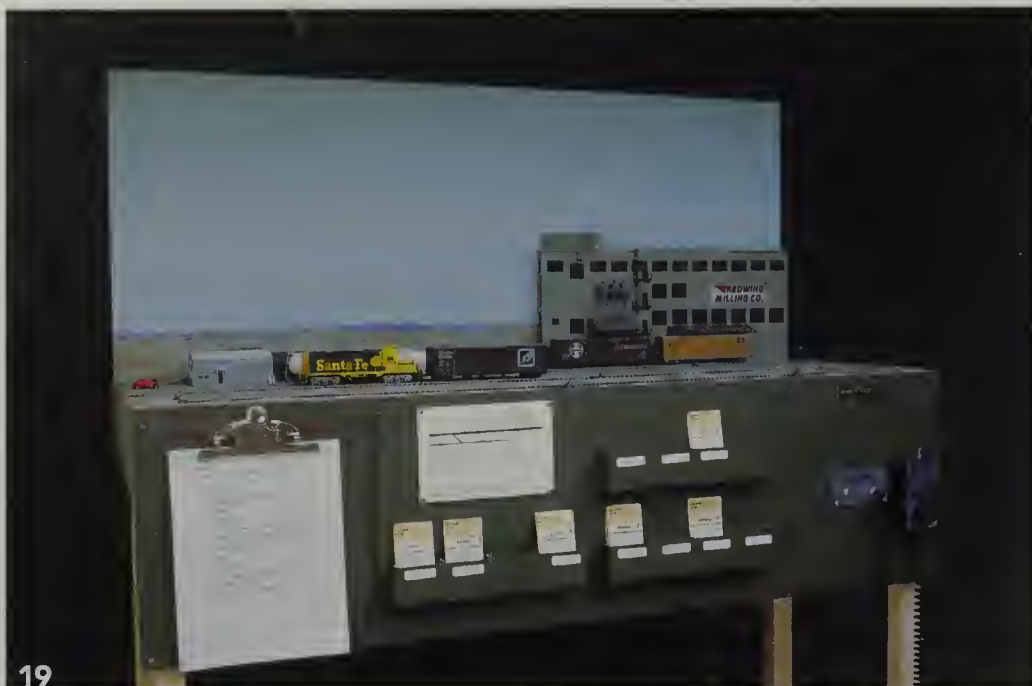
The basic premise of modular railroading is that anyone can build a module that matches a group's standards and then, at any time, meet with other members of the group to join their modules together. The success of Ntrak has shown this to be a popular option. Some choose to build a module because they don't have room for a larger layout. Others might build a single module but integrate it into a larger permanent layout.

Figure 17 shows dimensions and specifications for Ntrak's standard 4-foot module. Ntrak offers several other options as well—modules can be built in 6- and 8-foot lengths as well as inside and outside corner modules. See the Ntrak website (www.ntrak.org) for details.

Ntrak modules feature three through tracks, but another N scale option is



David Barrow built his HO scale layout in sections that he calls dominoes.



19 Each domino is a complete section of layout, with four legs, fascia, and backdrop. *David Barrow*



20 Joining the dominoes together results in a complete layout. The dominoes are easily rearranged, and individual dominoes can be rebuilt with different track and scenery configurations. *David Barrow*

oNetrak, which only has a single main track. Information can be found on the Ntrak website. An HO scale option is Free-mo (www.free-mo.org).

Modular design works well for portable club layouts. That way, if a member or two can't make it to the show with his modules, the remaining modules can still be rearranged to make a smaller layout. Here are a few things to remember when designing and building a module or series of modules:

- Each module should stand by itself, with its own set of legs, and each leg should have adjustable feet.

- Electrical connections between modules should be via plugs and sockets to make for easy connections. Each set of electrical wires (track power, signals, switch machines, etc.) should have a unique plug and socket design.

- Turnouts and curved track should be avoided above section or module joints.

Sectional layouts

Most sectional layouts fall into two categories: those designed to be moved often, such as a club or individual who brings a layout to shows, and those de-

signed to be moved once, such as when a modeler buys a new home.

If you want a layout that fits the first category, build it using the key points listed above with modular layouts. Ray and Renee Grosser's Soo Line layout is an example, **16**.

Another example is what modeler David Barrow has done with his HO scale Cat Mountain & Santa Fe layout. David built the layout in 2 x 4-foot sections that he calls dominoes to make it easier for him to rearrange and change the layout plan, **18**. It would certainly make the layout easier to move to a different location as well.

Each domino includes a plywood fascia and backdrop and the track arrangement varies from section to section, **19**. The design uses a great deal of lumber, it but certainly accomplishes its goals, **20**.

Points to consider

It is extremely rare for a layout to survive a move unless it has been designed to move in the first place, and even then, many don't wind up in a new space intact. Moving a layout is a lot of work—talk to someone who has done it before building a layout designed to be portable or moveable.

Many modelers discover that a move is a chance to start fresh in a new space, but if you're certain you'll want to move your layout, design it that way from the start. A couple of factors to keep in mind:

- The space that you're moving to might not match the existing space well enough to use all layout sections. This might still be okay if you can use the sections with minor modifications or if you can use most of your existing sections.

- Keep the size of each section manageable. Not only must you be able to get it out of its current location, you must make sure that it's small enough to get into its next home. Don't consider just table size—hills and other scenic details can add several inches. Eight feet is too long—six feet is better, and four feet will be much more manageable, with a two-foot width.

- Use terminal strips or other connectors to make electrical connections between sections. Label all connections and wires upon initial installation.

- Provide a positive alignment mechanism between sections. Carriage bolts or dowels work well.

- Avoid turnouts over section joints.

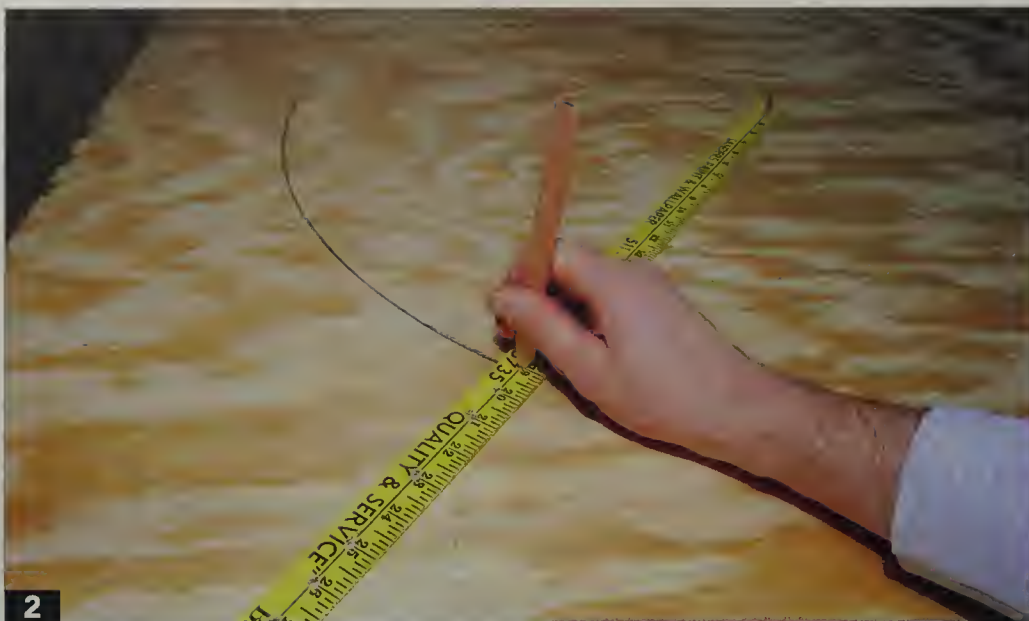


Subroadbed

Cookie-cutter and free-form roadbed

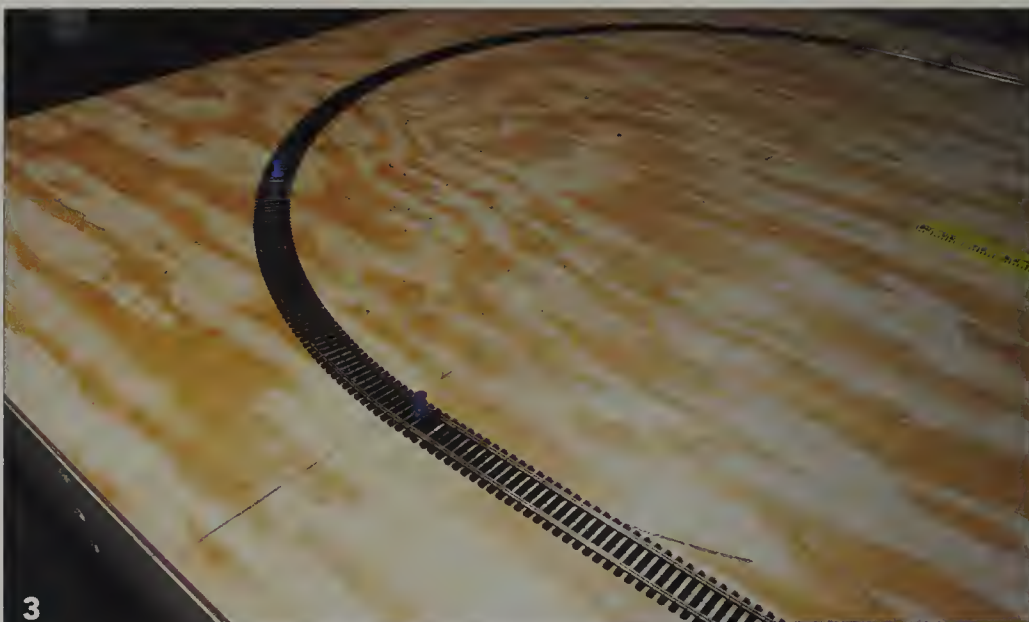
For beginning modelers, building a table with a flat plywood top is the obvious first choice, but it can also be quite limiting. A flat table makes it handy to try different track arrangements and place buildings and other details, but scenery, even for a layout based on a flatland railroad, doesn't get interesting until you start to vary the elevations of the track and other elements.

Cookie-cutter benchwork involves cutting out the roadbed, roads, lakes, and other features and then raising or lowering them as needed.



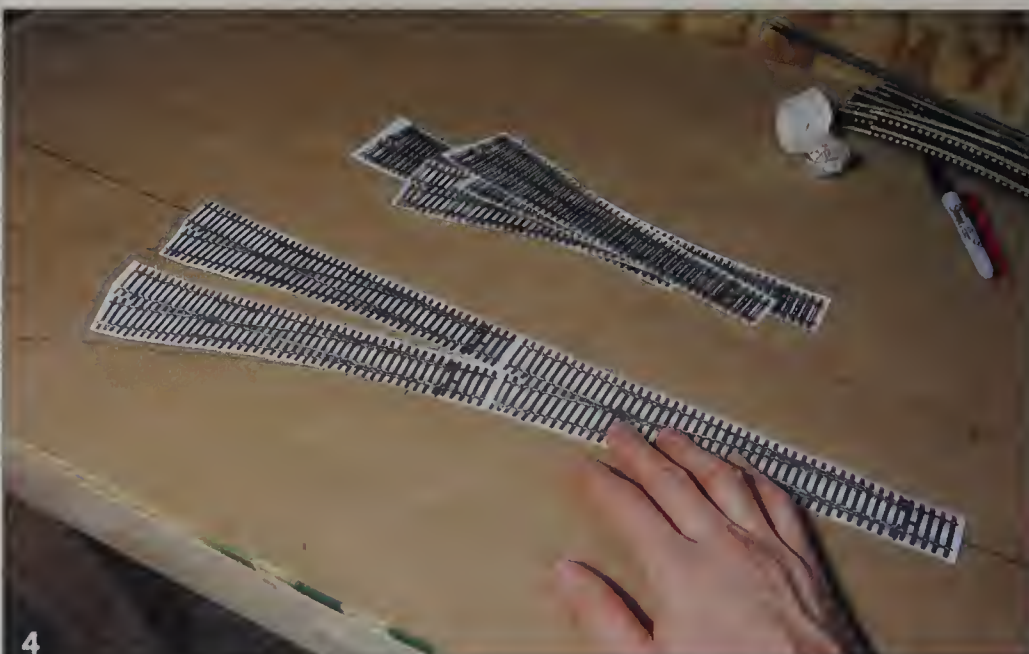
2

An old wood yardstick makes a handy compass. Drill pencil-size holes at every inch mark where you need curves.



3

Test-fit the track in place, especially with sectional track or complex arrangements. Pushpins will hold it in place.



4

Photocopies of turnouts and crossings work well for testing track arrangements.

Look at railroad roadbed in real life, and you'll find that the tracks are elevated above the surrounding scenery. Highways are also elevated. Hills rise above the scene, and valleys, ravines, and rivers go below normal ground level. There are several methods of capturing this look on a model railroad.

Cookie-cutter

Among the best methods of getting separations in elevation is the cookie-cutter technique, 1. The basic idea is very simple. After outlining the track, roadbed, and other scenic details on a sheet of plywood, you cut away various areas as needed to elevate or recess the track, roads, rivers, and other details.

A big advantage is that this provides a continuous layer of subroadbed for the track, allowing smooth grade transitions and grades as steep or as gradual as you need.

The cookie-cutter method is very flexible. You can leave as much of the table portion in place as required for towns and large industries, or remove it or recess it for low areas.

Let's take a step-by-step look at the process. The first step is to draw your track plan on the plywood. We'll do this on a 1/2" plywood top, which is placed on the grid table built in Chapter 2. If you're transferring a plan from a published plan or one that you've drawn to scale, it can help to draw grid lines on the table.

Draw track centerlines, using a long ruler or straightedge for straight sections. To draw curves, you can make a compass from a wood yardstick, 2. Drill a hole at the 1" mark large enough to place over a wire nail at the center of the curve. Drill additional holes at locations to match the radius of your track—for example, 19" for 18" radius curves (the extra inch makes up for the lost inch at the end).

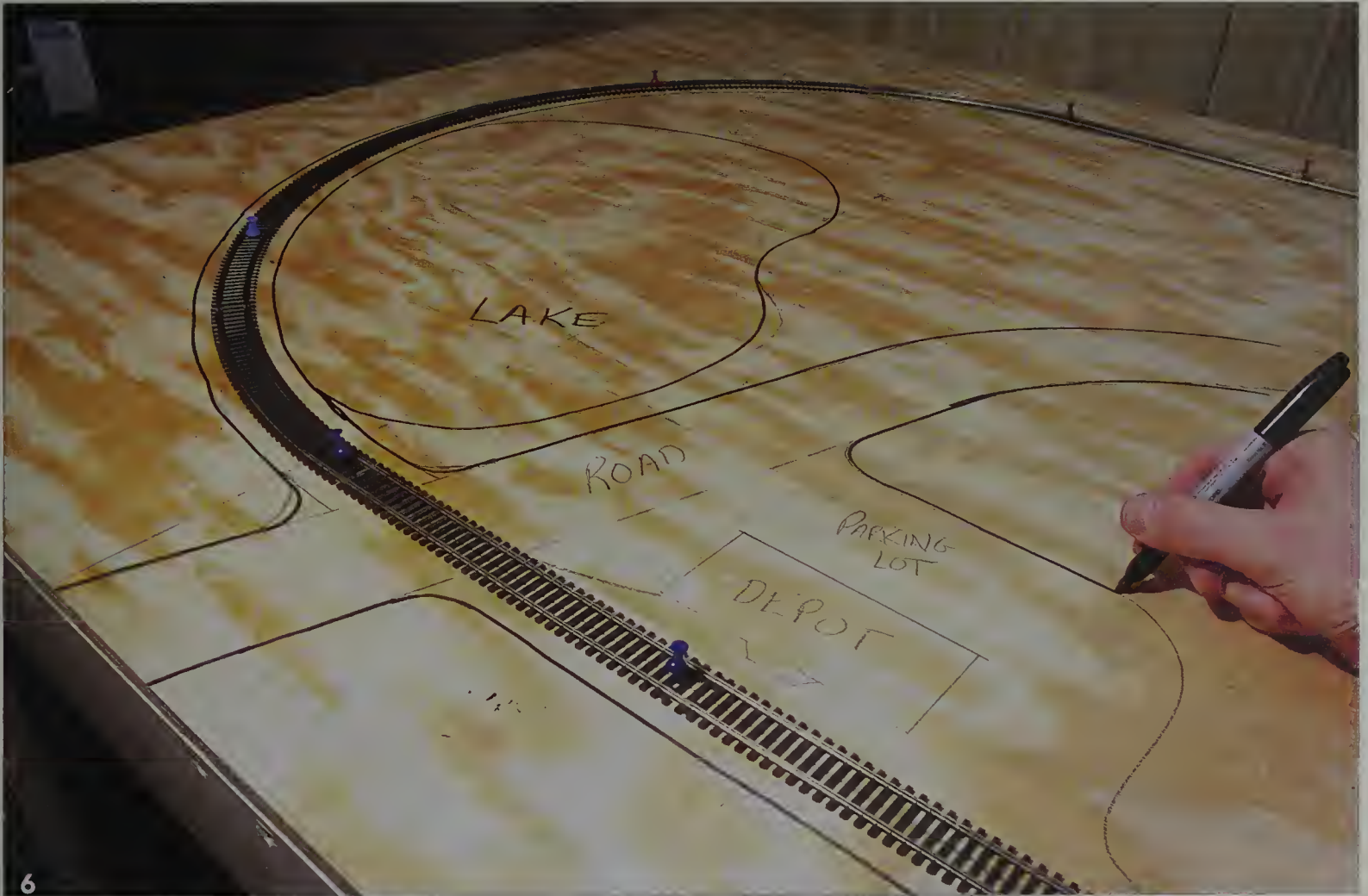
Tack a nail in place on the table at the center of the curve. Place the end hole of the yardstick on the nail and then insert the pencil through the appropriate hole to draw the curve.

You can also make curve templates for various radii as shown in the sidebar on page 54. These are handy, especially if the center point of the curve is located off the layout top.

Whether you're following a published plan or designing your own, it's a good idea to lay the track in place to make sure it fits following the plan, 3.



Along with track, pencil in details such as roads, lakes, rivers, structures, and parking lots.



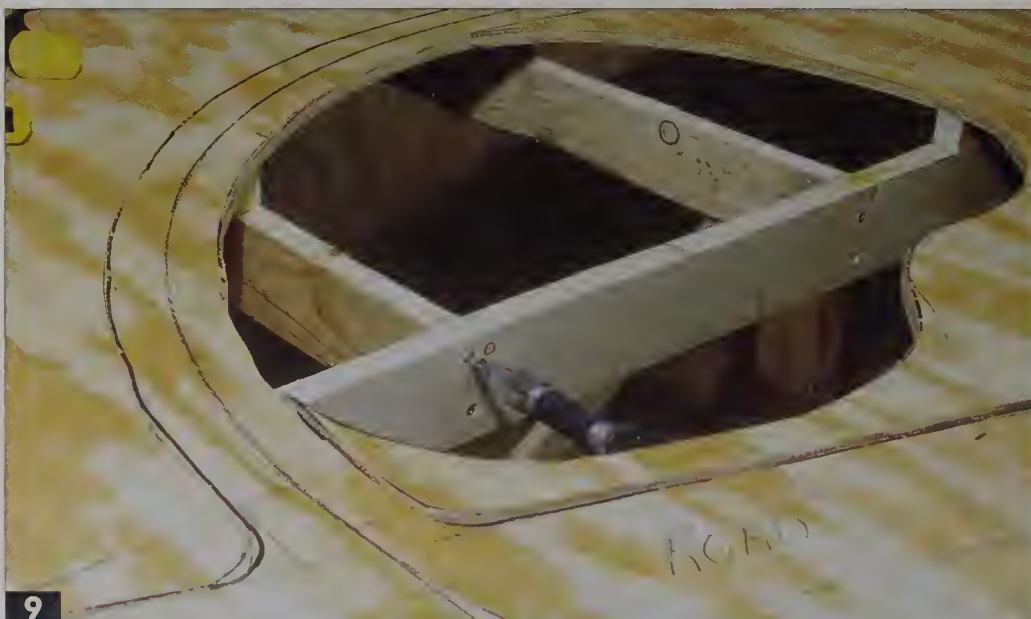
Determine areas to be cut and then outline the cutting line with a permanent marker.



7 Cut the plywood with a saber saw. Use lumber scraps to elevate the table, so the saw doesn't cut the girders.



8 Dropping the lake below the table area requires cutting the joist below the lake. Here the joist has been marked.



9 The joist has been cut, and two additional cross joists have been added to support the lake and the curved roadbed.

This isn't as vital if you're using flextrack for curves, but if you're using sectional track, it's important to make sure it matches what you've planned.

You should also do this in areas of complex trackwork where multiple turnouts or crossings come together, 4. You can set the actual pieces of track in place or use photocopies of turnouts on the plywood or a sheet of paper to help lay out these areas.

Once the track is in place, use a pencil to sketch other details, such as roads, streets, sidewalks, and structures, as well as scenery details such as lakes and rivers, 5.

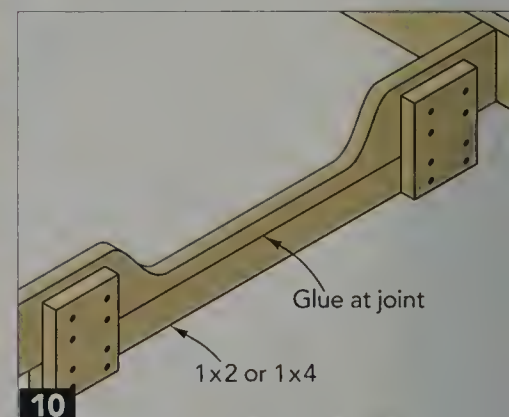
When you're sure of the locations of these details, use a felt-tip marker to highlight the lines that need to be cut, 6. For grade-separated crossings between railroads and roads, rivers, or other railroads, you generally want to cut the upper line to match the length of the bridge being used.

You can leave the plywood in place and use a saber saw to cut along the marked lines, 7. Raise the plywood above the table frame with 2 x 2 scraps to keep the saw from cutting the frame or joists.

The lake on the table should be recessed below the table surface, 8. The complexity of this depends upon the location of the frame members. As the photo shows, there was a single joist under the lake that had to be cut.

Start by marking the depth of the cut on the joist—I cut mine an inch below the top with a saber saw, 9. If you cut down more than half the depth of a joist, then reinforce it as figure 10 shows.

As you cut the subroadbed, you'll find areas where you need to add additional cross joists. In photo 9, you can see where I added two to support both the



10 Attach an additional support if you need to cut a joist to less than half its original depth.



11 The plywood lake bed can now be added. Countersink the screwheads to make way for scenery materials.



12 Once cut, the plywood subroadbed becomes very easy to move up and down.



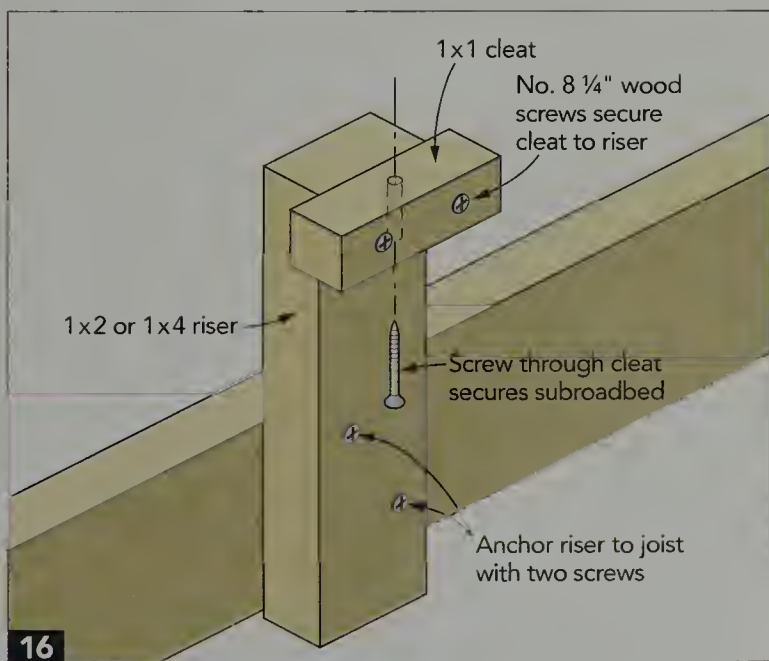
13 Clamp a riser in position at the subroadbed's highest elevation. Don't screw the riser or subroadbed into place.



14 Clamp the intermediate risers into position, making sure the grade is smooth and even. Screw the risers into the joists.



15 You can drive a screw through the subroadbed into the riser but make sure the screwhead is countersunk so it will clear the roadbed.



16 A safer option for risers is to attach the subroadbed from underneath via a cleat attached to the riser. This makes it easier to make changes at a later point in construction.



17

With an L-girder frame, low-level features such as this riverbed can be secured directly to the girders.

18

You can elevate the riverbed on shallower joists (here, 1 x 2s). The joists don't have to be perpendicular to the girders.



19

The cookie-cutter technique works the same on an L-girder framework as it does on an open grid. The extra 1 x 2 under the joists will eventually help support the fascia.

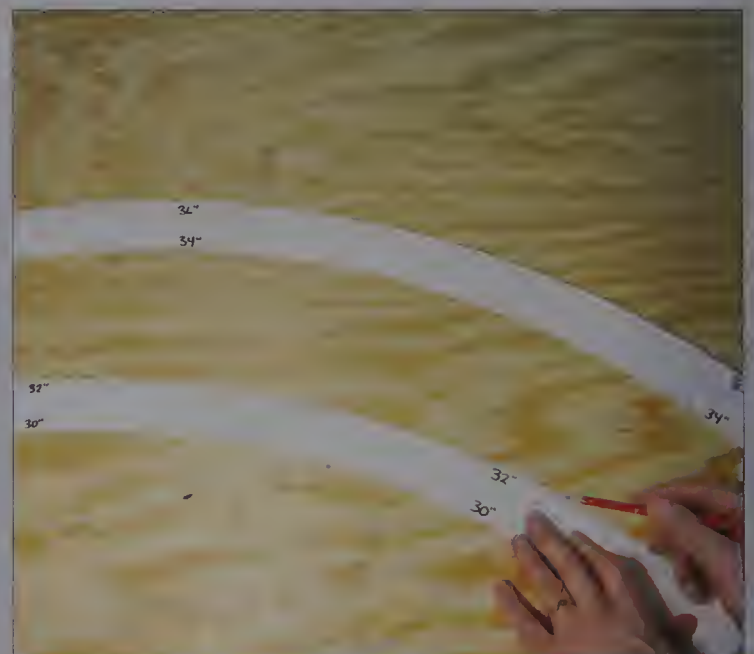
Curve templates

Templates make it easy to draw curves in full size. You can set them on top of the benchwork and get a good idea of the space taken up by a curve of a particular radius. When you're drawing full-size plans, they ensure accurate measurements.

I made my templates from large pieces of .060" styrene that I had handy. (You can buy styrene in 4 x 8-foot sheets from plastics dealers in most medium-size and larger cities.) You can also use hardboard or thin plywood. Cardboard also works but isn't as durable.

To make a template, use a 1 x 2 or other long stick as a compass. Tack one end of the stick to a piece of plywood atop sawhorses. Draw an arc of the desired radius on the styrene. I have a different radius on each side, as the photo shows. Label the template, cut it out, and it's ready to use.

My templates are each about 40" long. That seems to be a good length. Any longer and they become awkward to use; if they're shorter, it's difficult to lay out and judge long curves.



Templates can be cut from large sheets of styrene plastic (shown), hardboard, thin plywood, or cardboard.

lake and the track subroadbed around the curve.

Cut notches in the new joists to match the original joist beneath the lake and screw the new joists in place. A general rule of thumb is to support the roadbed at least every 16"-18". Fasten the lake cutout—now the lake bed—in place on the cutout joists, 11. Make sure you countersink the screws.

Subroadbed

You can now secure the subroadbed at whatever level and grade you need, 12. To secure the subroadbed, you'll need to add blocks of wood called risers to the joists. Cutoff scraps of 1 x 2s and 1 x 4s (depending upon the width of the subroadbed) make ideal risers.

Start by clamping a riser under the roadbed at the highest elevation, 13. Make sure that the roadbed is level and that the top of the riser is in full contact with the underside of the roadbed. You can then screw the riser in place.

Follow this by clamping additional risers along the grade, 14. Adjust the height of each riser so that the grade is smooth, screw the risers in place, and secure the roadbed to the risers.

For cookie-cutter tops where it's not likely that the subroadbed location will change, you can simply drive a screw through the roadbed into the top of the riser, 15. Make sure the pilot hole is countersunk so that the screwhead is completely below the subroadbed surface. If you think you might make later changes, you can use risers with cleats, 16. You'll see more about these later when we look at free-form roadbed.

If you're placing a cookie-cutter top on an L-girder table, it's a bit easier to add low-level details, such as rivers and roads, that run off of the layout edge. To do this, cut out the river at the width and shape you need. It can be secured to the girders themselves, 17, or to lower-profile joists, 18.

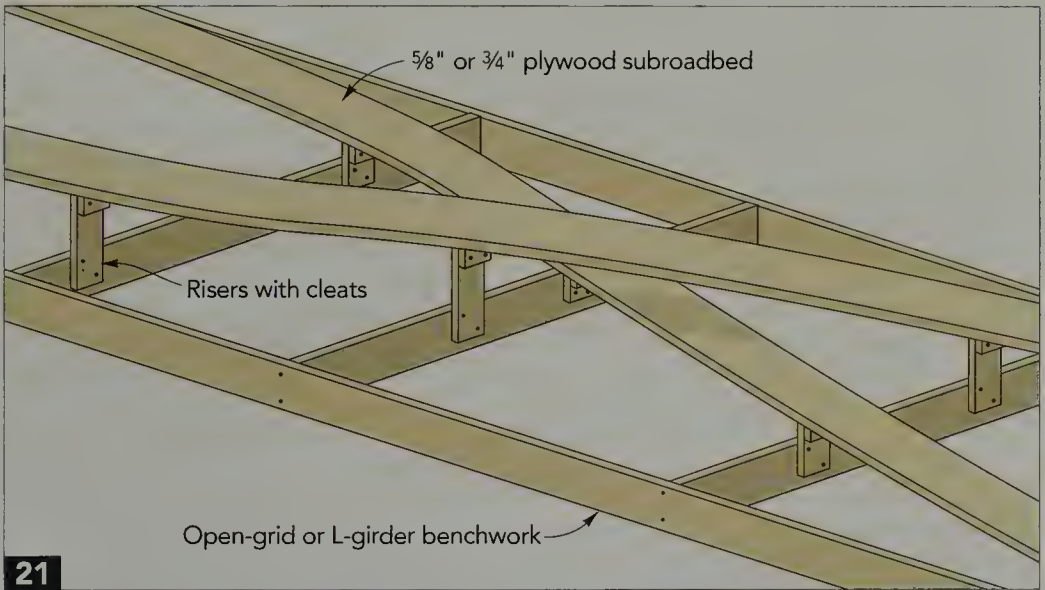
Otherwise, placing a cookie-cutter top on an L-girder table requires the same basic techniques as the grid framework, 19.

Open-grid with plywood subroadbed

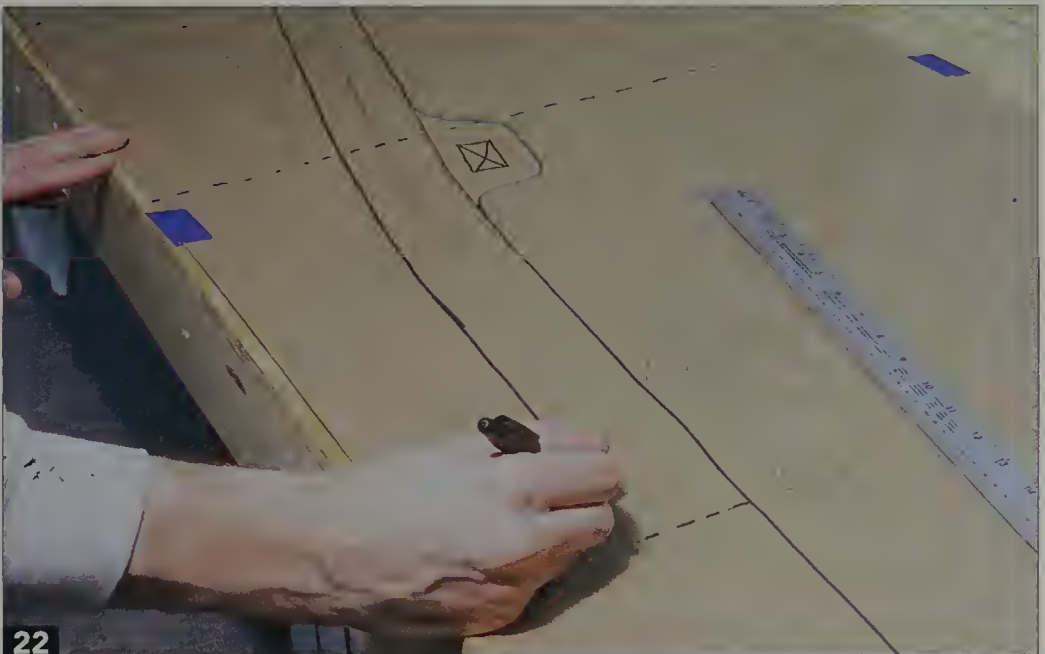
A variation on the cookie-cutter technique is open-grid with subroadbed, 20. This features free-flowing subroadbed, usually made of plywood, attached to an open grid or L-girder framework with risers. It is among the most



20 Here's an example of free-flowing plywood subroadbed over open-grid benchwork. The hilly scenery to come doesn't require a solid table surface.



21 Open framework with free-flowing subroadbed works well in many situations, especially rural areas and hilly or mountainous terrain.



22 Use a pencil to draw track centerlines and scenic details. Follow this with a marker to indicate cut lines and to show joist locations.



23 Cut out the paper templates with a hobby knife or utility knife. A steel rule helps insure straight cuts.



24 Tape the templates to the plywood. Outline them with a pencil or marker. Using photocopies ensures that there is room for the turnouts on the subroadbed.



25 Mark turnout placement on the plywood by using a scribe or awl to poke an indentation at throw bar locations.

common techniques for medium- and large-sized layouts. Figure 21 shows the basic idea.

The method's basic premise is that, unless you're modeling the prairie or a big city where you need the large flat surface, covering the entire layout with plywood isn't economical or practical. You can still use smaller pieces of plywood under areas such as towns, single structures, rivers, and roads.

Plywood is the most common subroadbed material. It's strong, dimensionally stable, and economical—you can get a great deal of subroadbed from a single 4 x 8 sheet. I've had good luck with $\frac{5}{8}$ " A-C or B-C fir plywood, but some modelers prefer the extra strength of $\frac{3}{4}$ ". Whichever you choose, when shopping for plywood, check the stamp as described in Chapter 1—always buy the stronger Group 1 plywood if possible.

Start by making a full-size drawing of your track plan. I like to mark the plan onto paper, full-size on the benchwork. (Another, and in many ways easier, method is placing the paper on the floor before beginning benchwork assembly.) Brown wrapping paper is inexpensive and handy: you can



26 Assemble the risers and cleats before adding them to the layout.

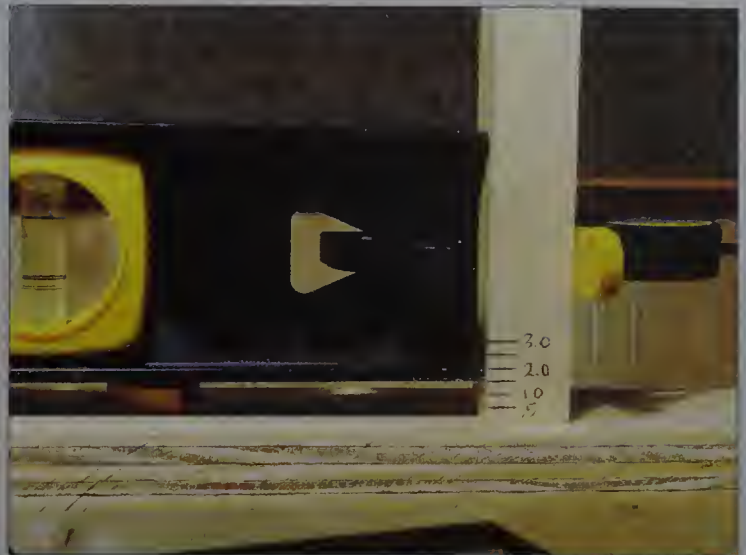
Grade gauge



You can make a simple grade gauge by clamping a block on the end of a level.

The grade, whether on a model railroad or a real railroad, is measured in percentages. This is simply a measure of how much the roadbed rises or drops compared to the length of the run. A 1 percent grade rises one unit for every 100 units of run—for example, 1 inch for every 100 inches. To calculate the grade, divide the rise by the run. In the above example, $1 \div 100 = .01$ and then move the decimal two places to the right to see the grade: 1 percent. Odd numbers are easy to calculate: for example, a rise of 2.5 inches along 130 inches of benchwork would be 1.9 percent ($2.5 \div 130 = .019$). Remember that calculating the grade has nothing to do with scale.

A simple grade gauge will make it easier to quickly figure out the grades on your layout. To make a grade gauge, take a standard carpenter's level and clamp a stick to one end (I used a scrap piece of $\frac{3}{4}$ "-square plain molding). Mark the stick in increments from the bottom end and label them to



The bottom of the level should match the mark for the desired grade. This shows a 1.5 percent grade.

GRADE	LENGTH OF LEVEL		
Percentage	12"	24"	36"
0.5 percent	.06"	.12"	.18"
1.0 percent	.12"	.24"	.36"
1.5 percent	.18"	.36"	.54"
2.0 percent	.24"	.48"	.72"
2.5 percent	.30"	.60"	.90"
3.0 percent	.36"	.72"	1.08"
3.5 percent	.42"	.84"	1.26"
4.0 percent	.48"	.96"	1.44"

indicate the grade. The chart shows where to place the markings, depending upon the length of your level. The photo shows a 24"-long level, so my lines are .12" apart.



27

Attach the cleat to the riser with a pair of screws in countersunk pilot holes.



28

Hold the subroadbed down on the riser and make sure the subroadbed is level from side-to-side.



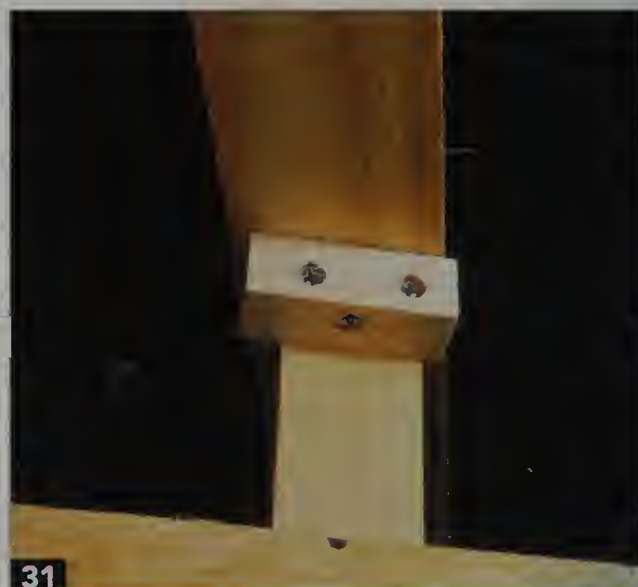
29

Clamp the risers in place, checking that the subroadbed is level or at the proper grade.



30

Keep the clamp in place as you secure each riser with a pair of screws.



31

Drive a screw up through the cleat into the plywood to secure the subroadbed.

buy it at office supply stores in 24"-wide rolls in 50- and 100- foot lengths.

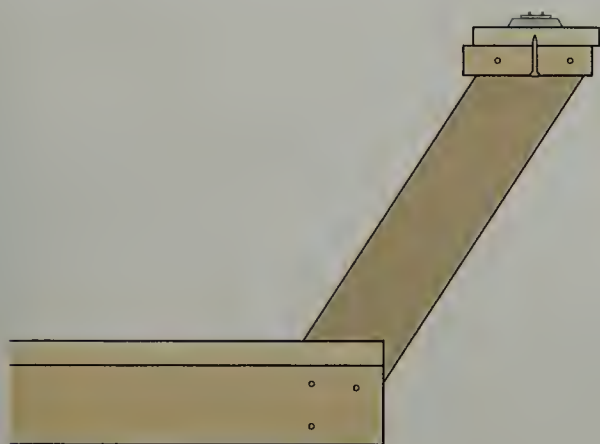
Use a pencil to rough in the track plan, 22. Templates are handy for roughing in the curves. For sharper curves, you can use a yardstick as a compass as shown earlier. For straight track, 3- and 4-foot aluminum rulers are

handy, and for long straightaways, use the straightest 1 x 2 you can find.

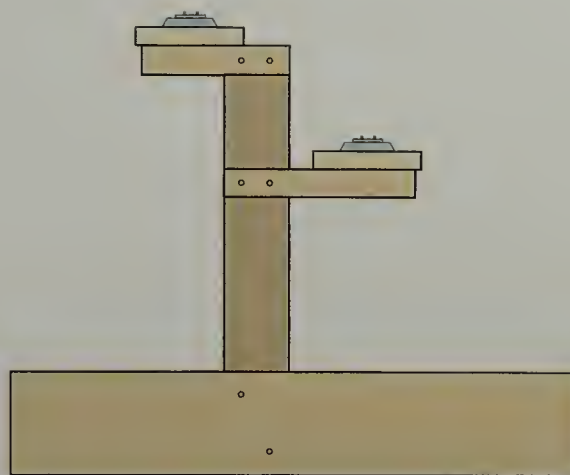
Once you've drawn the plan on the paper, measure and mark the width that the subroadbed needs to be. This will vary depending upon your scale, the type of roadbed you plan to use, and how much of a shoulder you desire.

About 2½" is typical for HO scale; 1½" for N, and 3¾" for O scale. As you're drawing the subroadbed outline, be sure to mark areas where you need to leave the surface wider for trackside structures and other details. Also mark the location of joists and joints between grid sections.

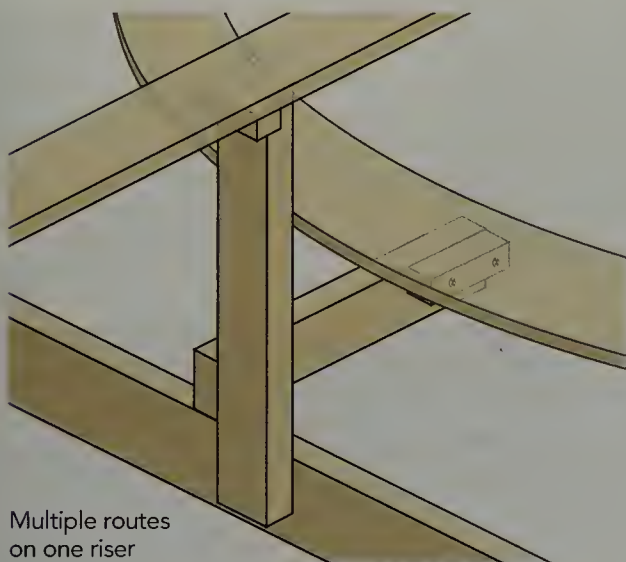
ALTERNATE RISER INSTALLATIONS



Angled riser



Off-center mounting,
multiple supports on one riser



Multiple routes
on one riser

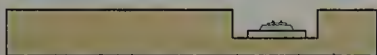


Wide roadbed,
off-center mounting

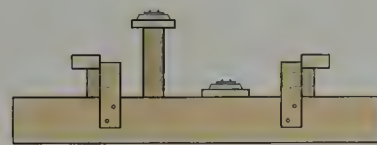
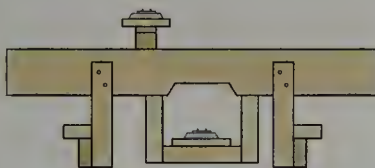
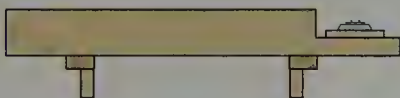
32

LOW-LEVEL SUBROADBED MOUNTING

Open grid



L-girder



33

Use a hobby knife to cut out the paper following the outlines of the subroadbed and other features, 23. The pieces will serve as templates in cutting out the plywood. Label the pieces of paper, so you'll be able to arrange the finished pieces of subroadbed once they're cut from the plywood.

Place the paper templates on the plywood. Since an 8-foot run is the best you can get from a sheet of plywood, you'll have to cut the subroadbed templates in places. Avoid making these cuts within 5" of the marks indicating joists and grid joints. Position the templates to get the most

subroadbed out of the wood with the least amount of waste.

Tape the templates down and use a pencil or marker to outline them, 24. Be sure to label them to make it easier to get them on the layout in the proper order. The photo also shows how to use photocopies of



34

Make sure subroadbed joints occur between risers.

turnouts to ensure that the space will work out.

Mark the turnout locations on the plywood to make it easier to place them later. I mark the throw bar location with a scribe, **25**, so I know where holes will need to be drilled for control wires from undertable switch machines. Make sure that the throw bar locations don't end up atop risers.

Use a saber saw to cut out the subroadbed sections and then position the sections atop the grid.

Risers

Changing elevation and adjusting grades is a matter of using risers. It's a good idea to use risers even if your track will be level, as doing so makes it easy to keep the track above the base scenery. It will also be easier to add scenic details such as lakes and rivers below track level.

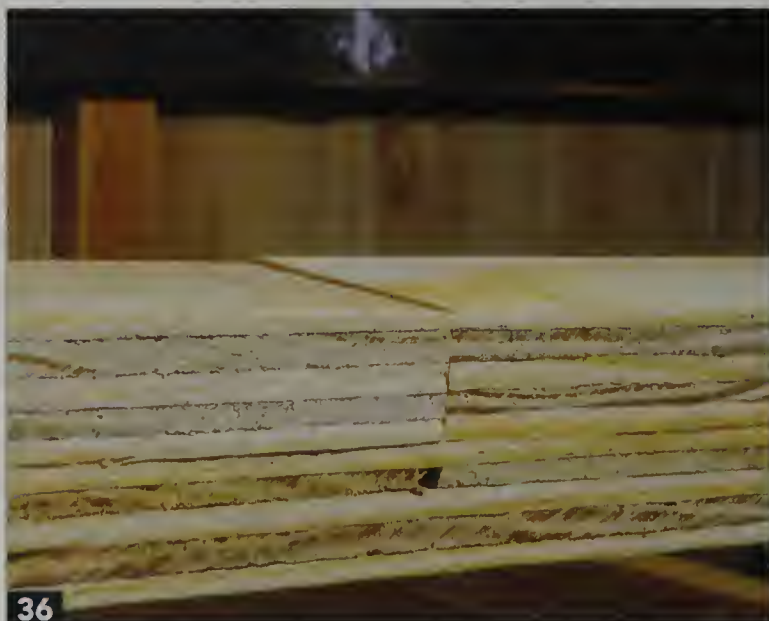
Figure **16** shows a basic riser with cleat; you can see a finished riser in **26**. Note how the risers are attached to 1 x 1 cleats, with a screw from under



35



Glue and screw the splice plate in place, making sure that the joining sections of subroadbed are aligned properly.



36

Plywood will sometimes vary just a bit in thickness. This could cause a bump in the roadbed.



37

You can quickly shave down the taller piece of plywood with a Surform rasp.



38

Support wide elevated areas, such as yards or towns, with a pair of risers connected by a 1 x 2.



39

If the distance between risers exceeds 16" or so, adding an additional riser is a good idea.



40

Cut an additional joist to fit, at an angle if necessary, and screw it into position. Add risers as needed.



the cleat into the subroadbed. Using a cleat keeps screwheads from interfering with the roadbed and makes it easy to move a riser after the track is laid if it becomes necessary (which happens more often than one might think).

A 1 x 2 is usually sufficient for a riser. You can cut your own cleats, or you can use $\frac{3}{4}$ "- or 1"-square molding. Cut the cleats as wide as the subroadbed. Attach the cleat to the riser with a pair of screws (drill countersink holes first) but first drill the center pilot hole for mounting the cleat to the subroadbed, 27. Drill this hole at a slight angle away from the riser to make it easier to get the screw bit in the space.

Begin installation by clamping a riser in place at the highest elevation. Make sure that the riser is level across the subroadbed, 28. Install a riser at a lower level and then add the risers in between,

clamping (not screwing) the risers in place as you go, 29.

A carpenter's level with markings is a handy tool for calculating grades (see page 57). A flat Midwestern railroad should limit grades to 1 or 1.5 percent at maximum, while a mountain railroad might have grades up to 2.5 percent. You can get away with steeper grades on smaller layouts where shorter trains are run, but even then, 3 to 3.5 percent is quite steep.

Once you're sure that a series of risers are in the proper place, you can mount each to the joists with a pair of screws, 30. Add a screw from under the cleat to secure the subroadbed, 31.

You can get creative in installing risers. Complex trackwork may require some unorthodox riser mounting methods, so it's good to keep in mind that risers don't necessarily have to be

attached directly under the track they support, 32.

Hidden track (below-main-level) can also require some creative handling. There are several ways of doing this, including cutting into a joist, extending a joist under the girders, or hanging track below a joist, 33.

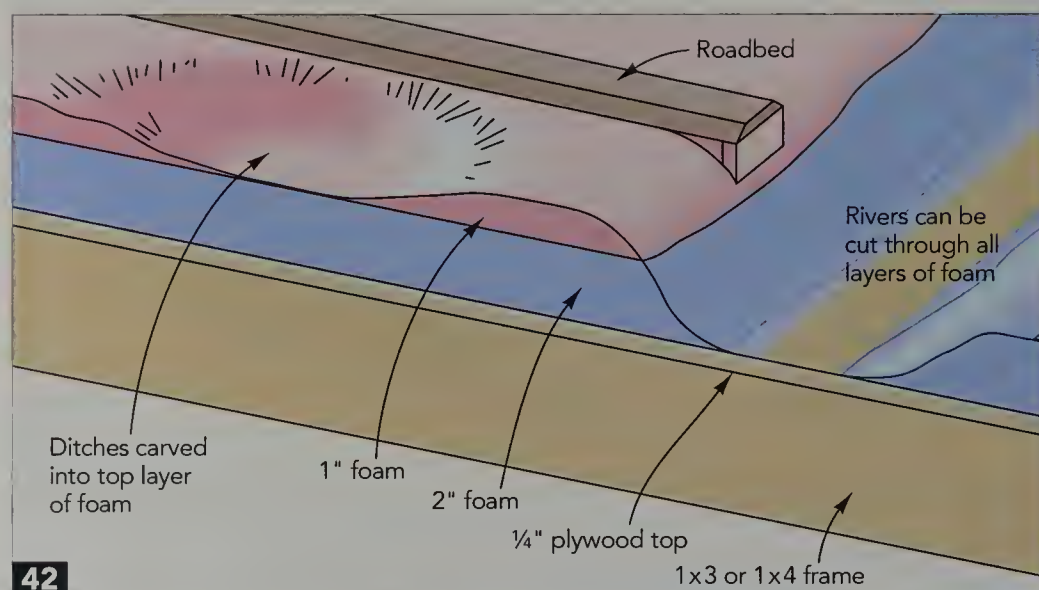
You'll sometimes have to join sections of subroadbed end to end, 34. Join the two pieces before anchoring the second piece of subroadbed to any risers, and make sure the splice is between risers. Make a splice plate of $\frac{3}{8}$ " or thicker plywood, 35. A good rule of thumb is to make the splice plate four times as long as the subroadbed is wide.

Drill pilot holes in the plate and start the screws (four per side). Spread carpenter's yellow glue on the splice plate and then clamp it in position. Drive the screws into place, and you'll have a solid joint.



41

Sheets of extruded foam insulation board (this is a 1½" board atop a 2" board) can be used as a table base, either directly on joists or on a thin plywood top.



42

The thickness of a plywood sheet can vary a bit, so it's possible to wind up with a joint where one piece is slightly thinner, 36. If this happens, use a Stanley Surform tool to shave down the taller piece, 37.

You can handle wide areas requiring support (such as yards and towns) by using a pair of 1 x 2 or 1 x 4 risers spread apart with a 1 x 2 horizontal member between them, 38.

As track curves, especially around corners, you'll find that you need to add additional supports, 39. For L-girder benchwork, this often means simply adding another joist atop the girders. For open-grid benchwork, add a new joist between existing joists, 40. I used a 1 x 4 for this example, but a 1 x 2 would have been sufficient. Hold the new joist under the grid and mark each end with a pencil. Cut the joist using a miter saw and then install it. Add the new riser, and that section is complete.

Extruded foam

Scenery based on extruded foam insulation board has been popular for some time, and more and more modelers have begun to use foam in benchwork applications such as subroadbed and tabletops.

Foam's advantages include its light weight and its ability to be cut and shaped without power tools, a big advantage if you're building a layout in an apartment or other area where using power tools is discouraged. You can place one or more sheets of foam directly atop the layout table, 41.



43

A knife can be used to cut the top layer of foam in cookie-cutter fashion. The roadbed section can be raised or lowered to change the grade and elevation, just like plywood.

A plywood base isn't necessary unless you plan to carve away foam all the way to the table, 42. You can use knives, hot-wire cutters (from Woodland Scenics, Hot-Wire Foam Factory, and others), rasps, or other tools to carve away the foam to create scenery contours, while leaving the track at a constant level.

You can add grade variations cookie-cutter style by cutting the top layer of foam at roadbed width with a conventional kitchen or steak knife (utility knives usually don't have long enough blades), 43. Scraps of foam or wood can be glued in place as risers under the cutout foam subroadbed. Chapter 6 includes more information on making your own hot-wire contour tools for foam benchwork.

Glue foam sheets together with latex construction adhesive (such as Liquid Nails for Projects), latex contact cement, or a foam-specific glue such as Woodland Scenics Foam Tack Glue. It can take some time (a couple of days in many cases) for each of these glues to dry, especially when dealing with sections several feet wide.

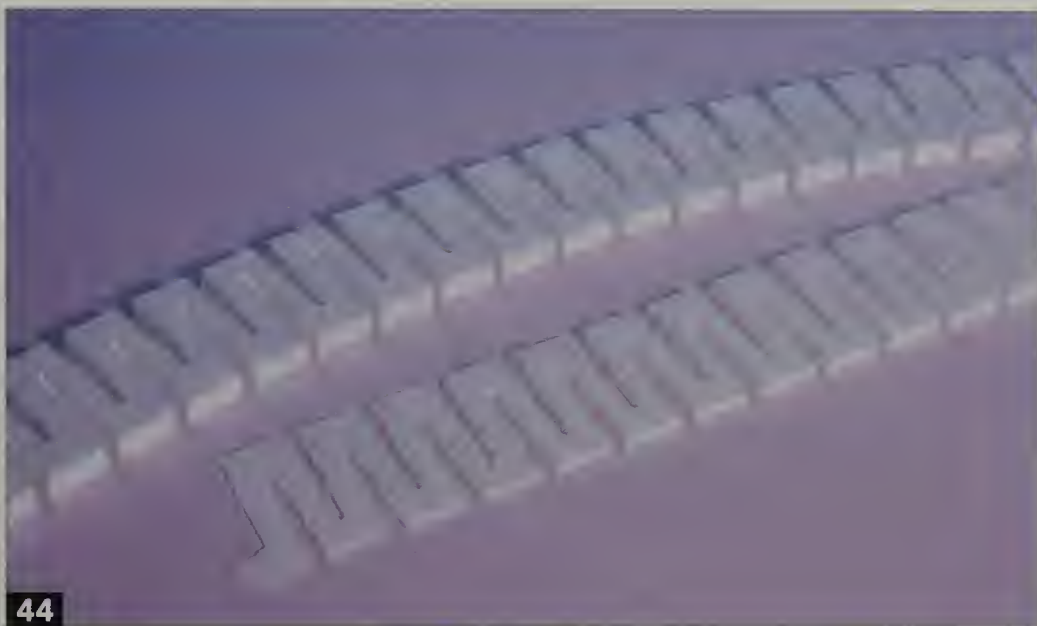
Another variation on this theme uses commercial grades and risers offered by Woodland Scenics, 44. The line includes flexible foam pieces with 2 and 4 percent grades, along with constant-level flexible subroadbed pieces (risers) that keep track elevated above the surface.

These pieces are designed to be glued atop a foam tabletop, covered by plaster gauze, and sanded smooth, 45; they are then ready for roadbed. The Woodland Scenics items can be limiting, with just two choices of grades and set heights for risers, but the method is a viable, lightweight alternative that you can build into a strong layout.

Roadbed

Once you have a firm, smooth, level subroadbed, the next step is to add roadbed that will provide your track a smooth, level, seamless bed to lie on, 46. Several materials will work well—here's a look at a few of the most popular options:

- **Cork.** Cork was among the first widely available roadbed materials and has been the hobby standard for many years, 47. It comes in 36"-long strips perforated at an angle down the middle. Peeling it apart provides two matching beveled halves, 48. It



44 Woodland Scenics makes flexible foam grades and risers in several heights. These can be glued to a foam or wood base.

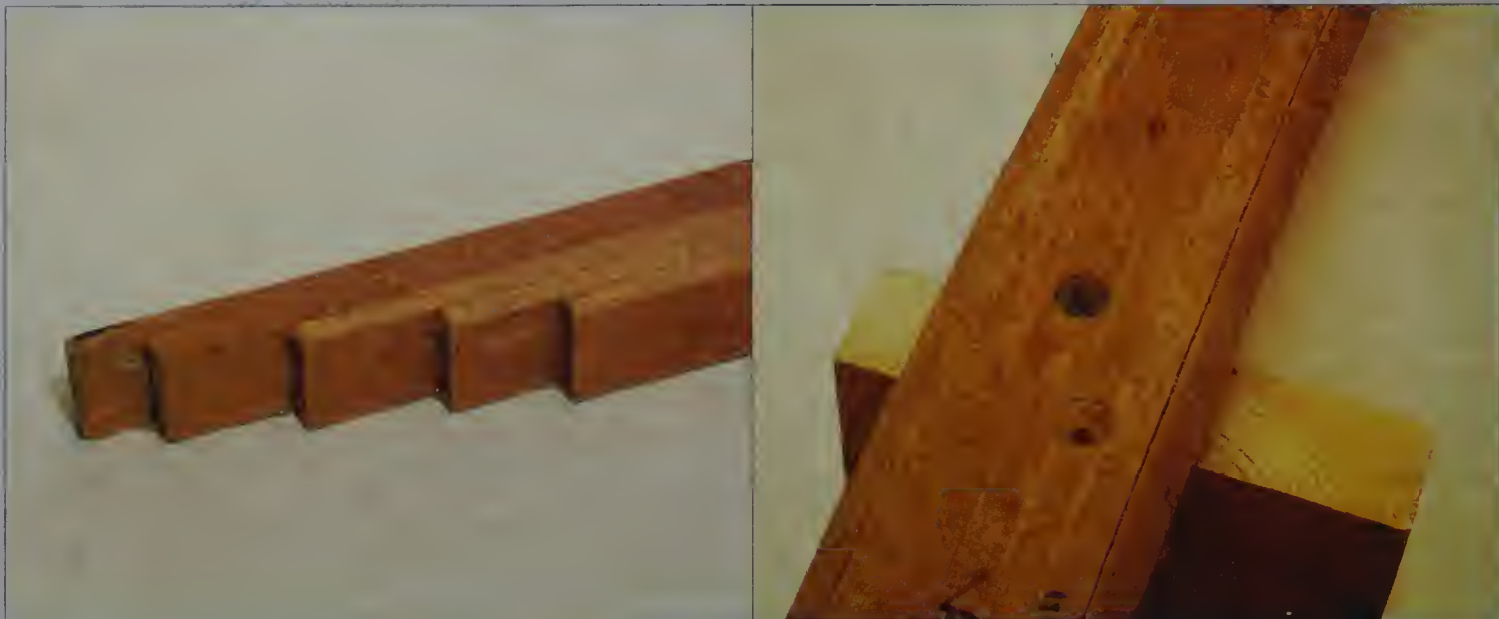


45 Curve templates can help determine riser locations. Test-fit track before gluing the risers in place.



46 Woodland Scenics risers can be combined with sheets of foam to form scenic contours.

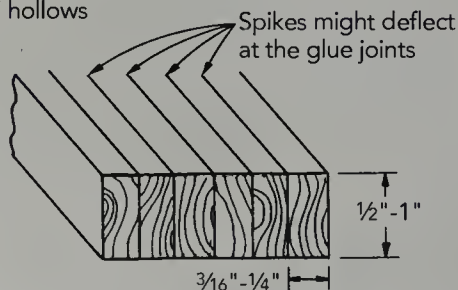
Spline Subroadbed



Joe Fugate calls his version of spline roadbed EasySpline. He forms it by laminating strips of $\frac{1}{4}$ " tempered hardboard. By cutting bevels on the outside pieces, Joe uses the material as roadbed, gluing the track directly in place on the spline.

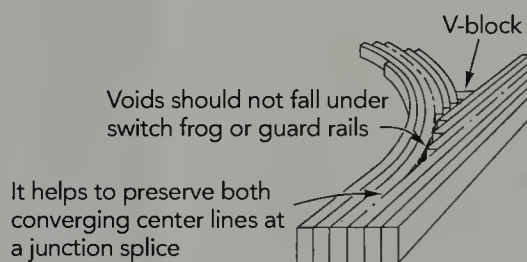
SPLINE CONSTRUCTION

Keep the vertical dimensions small enough that the roadbed will bend over humps and hollows



Any number of strips can be used to make roadbed of any width

SPLINE AT TURNOUTS



Spline, or laminated, subroadbed involves gluing together several narrow vertical strips of material to produce a base for roadbed. The technique's main advantage is that it produces smooth, flowing roadbed, especially on curves. The laminated strips make the method extremely strong, so the subroadbed can span several feet between risers.

Disadvantages include the time it takes to engineer and build as well as the time and effort required to cut all of the spline material. A table saw is almost mandatory for doing this—cutting the material with a handheld circular saw would be a cumbersome process.

You can use $\frac{1}{4}$ "-thick soft wood (pine or fir) or plywood, ripped to $\frac{1}{2}$ " to 1" widths, or $\frac{1}{4}$ " tempered hardboard. Hardboard will create much more dust when sawing than wood. With either material, figure on gluing the roadbed in position: track nails and spikes will not go in well.

A complete guide to this method can be found in Joe Fugate's article "Easy Spline Roadbed" in the March 2000 issue of *Model Railroader*.

Here are some basics: start by cutting enough strips for the layout. This will vary by the thickness of your material and the roadbed width needed: about $2\frac{1}{2}$ " for single track in HO, $1\frac{1}{2}$ " in N, and $3\frac{5}{8}$ " for O scale.

Attach risers in appropriate locations following the track. Start by placing the center spline in position. A nail driven vertically in the center of each riser can serve as a guide.

Run a bead of glue on the face of the second spline and clamp it to the first. Make sure the joints are staggered. Continue to do this around the layout. The drawing above shows how junctions can be done. Sidings can be made by widening the roadbed in areas as needed. Attach the roadbed to risers in the same manner as conventional roadbed.

is made in all scales, from N to O. Cork is flexible, making it easy to lay around curves. Cork cuts easily with a hobby or utility knife, so it's simple to make bases for turnouts and complex track arrangements. (Turnout-shaped pads and large sheets of cork are made by Midwest and IBL.) There's usually a rough burr along the top of the beveled edges, which you can get rid of using a sanding block and coarse sandpaper.

- **Track-Bed.** Made by Woodland Scenics, Track-Bed is a low-density foam product that comes as one piece (either 24" strips or a continuous roll) with beveled edges. It's made in N, HO, and O scales. The material is quite flexible, and it's the softest roadbed material. Like cork, Track-Bed is also available in large sheets for yards or complex track arrangements.

- **Homasote.** This dense fiber material holds spikes and track nails well, and experienced modelers regard it as the best choice for roadbed if you're handlaying track. It's sold in 4 x 8-foot sheets (and other sizes) as insulation board—go to www.homasote.com to find a dealer. You can cut your own Homasote roadbed from sheets, or if you don't want to do the work, another option is a product called Homabed, made by California Roadbed, 49. Standard Homabed comes in strips with one edge beveled, like cork, but it isn't flexible. The company offers strips with kerfs cut along one edge, allowing it to curve. It also sells flat sheets for cutting into turnout pads.

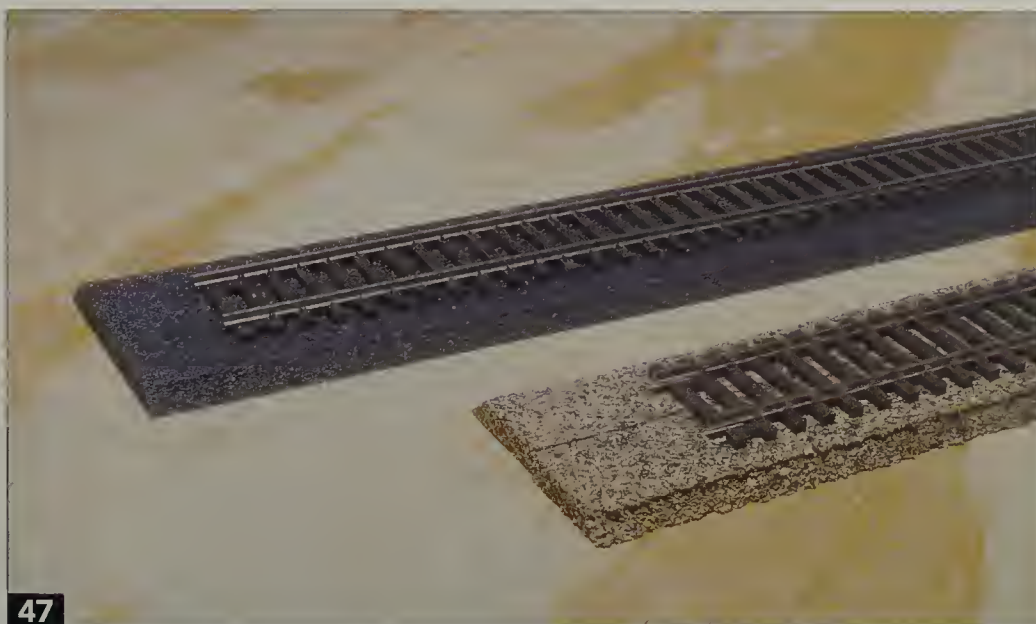
Securing roadbed

All of the above materials are best glued in place. Use white glue, except when gluing roadbed to foam, in which case, Woodland Scenics Foam Tack Glue is an excellent option.

For cork and Homabed, you can use the track centerline as a guide, but because Track-Bed is a one-piece product, you'll need to add a guideline at one edge of the roadbed.

For all but Homasote, you can use pushpins to hold the roadbed in place until the glue sets. For Homasote, either hold it down with pieces of strip-lumber with weights on top or clamp it to the subroadbed.

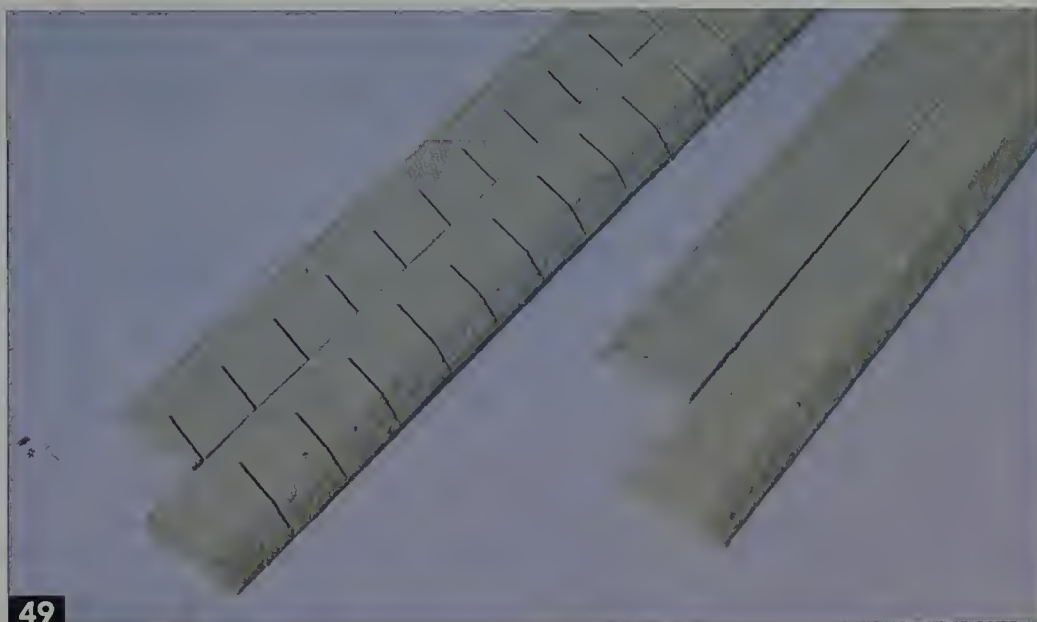
For more information on laying track and roadbed, see *Basic Trackwork for Model Railroaders* (Kalmbach Books, 2004).



47 Cork and Woodland Scenics Track-Bed are two of the most commonly used types of roadbed.



48 Cork roadbed is split at an angle down the middle and is separated and applied in two halves.



49 Homabed comes in beveled plain sections for straightaways (right) and cut with kerfs (left) to bend around curves.



Wall-mounted benchwork

Create more storage space with a shelf-style layout

Wall-mounted benchwork is versatile, saves on materials, and provides open space under the layout.

Mounting benchwork directly to walls offers many advantages over freestanding layouts. Wall mounting allows you to get rid of many, and sometimes all, legs, and it frees the space under a layout for storage. Wall-mounted layouts are solid and they look neat, as they allow a layout to naturally conform to the shape of the space available. You can wall-mount benchwork in a finished room as well as on a poured-concrete or concrete block wall. The keys to either are anchoring the benchwork firmly.



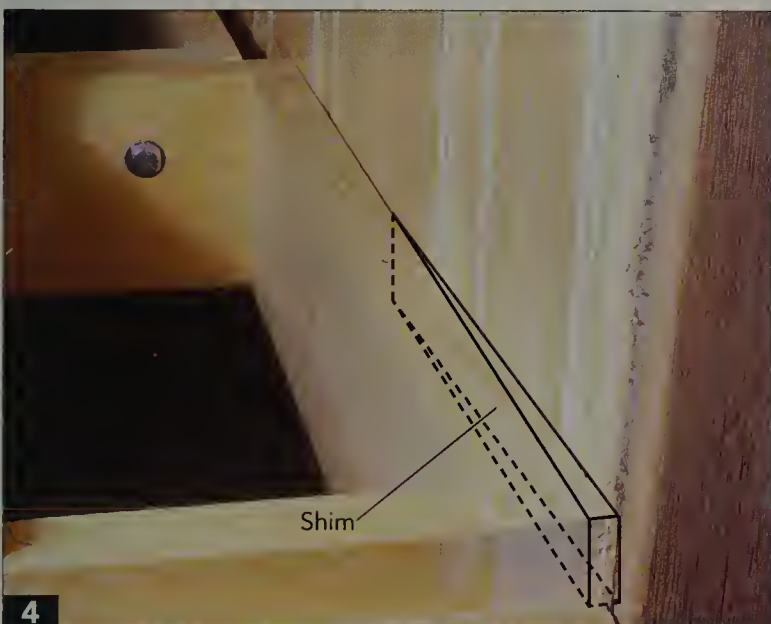
2

Clamp temporary legs in place to hold the frame at the proper height, drill pilot holes in the frame, and drive screws into the wall studs.



3

The first frame section is securely mounted to two walls in a corner.



4

If the wall corners aren't quite square, you may have to add a shim or two behind one side of the frame.



5

Clamp the second frame to the first. Make sure both are level and that the tops of the frames align.

The complexity of wall-mounted or shelf benchwork depends on your layout design. A narrow shelf featuring a level prairie railroad can be as simple as adding commercial shelf brackets under a board; a wide shelf with many hills and valleys will need more substantial framing.

You can design wall-mounted benchwork based on table, L-girder, or open-grid (butt-joint) styles as well as mixing styles. You can also combine wall-mounted and freestanding benchwork depending upon your available space.

Open-grid

An open-grid style framework can be secured directly to a finished stud wall, 1. The layout shown is 30" wide and features 1 x 4 framing, much like the freestanding layout shown in Chapter 4. This is a good way to mount a frame from 24" to 36" wide.

Start by assembling the framework to the desired size. As with a freestanding open-grid layout, the goal is to design the layout in a series of rectangles and boxes. Once the frames are built, anchor the wall side of each frame directly to the wall, 2.

Mounting screws must go into studs, not merely into drywall or paneling. Select screws long enough that at least 1½" of each extends into the stud. In the benchwork shown, the screws needed to pass through the ¾" benchwork frame, ¼" paneling, and ½" drywall. I used 3" stainless-steel deck screws with square-drive heads. At first glance, they look like silver drywall screws, but deck screws are much stronger than standard wood screws and have coarse threads that hold extremely well.



Join the two sections with a couple of carriage or hex bolts.



You can use standard legs with this layout style. A leg at every frame joint is usually sufficient.



Diagonal braces take up no floor space. A short length of 2 x 2 screwed to a wall stud gives the 1 x 2 brace a solid anchor at the bottom.



Simple homemade shelf brackets work well for narrow box-frame benchwork.

Clamp temporary legs in place to hold the frames at the proper height against the wall. Then, drive two deck screws through the frame into the wall at each stud location. In photo 3, you can see the first frame installed in a corner. If your layout room isn't quite square, you may have to use shims or spacers between the grid and the wall to square the frame, 4.

Continue adding frames from there, butting the second frame to the first, 5, and securing the joint with a pair of bolts, 6. Check the benchwork frequently with a level as you install the framework.

You have two leg options with this style of benchwork. You can simply bolt a 2 x 2 leg inside the frame at each joint between sections, 7. The layout will be stable enough that no

diagonal bracing is needed.

The less-obtrusive option is to add diagonal braces to the wall, 8. Attach a 6" length of 2 x 2 at the bottom of the wall with a pair of screws into a stud or footer. This will serve as an anchor for a 1 x 2 brace running up to the inside of the frame. A brace at each joint should be sufficient. Continue building the benchwork as you would for a free-standing layout.



10

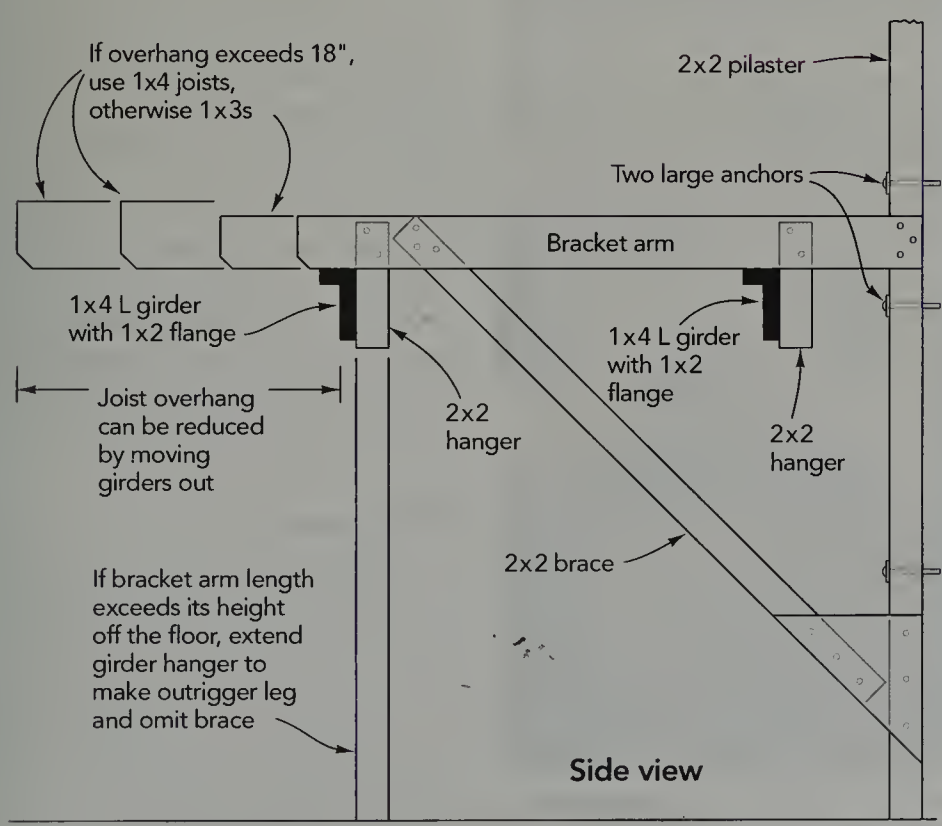
The narrow box frame takes up very little room. Fascia can be screwed to the front 1 x 3.



11

A narrow plywood shelf can be placed directly on commercial shelf brackets as long as it's supported every 18" or less.

BASIC SHELF BRACKET

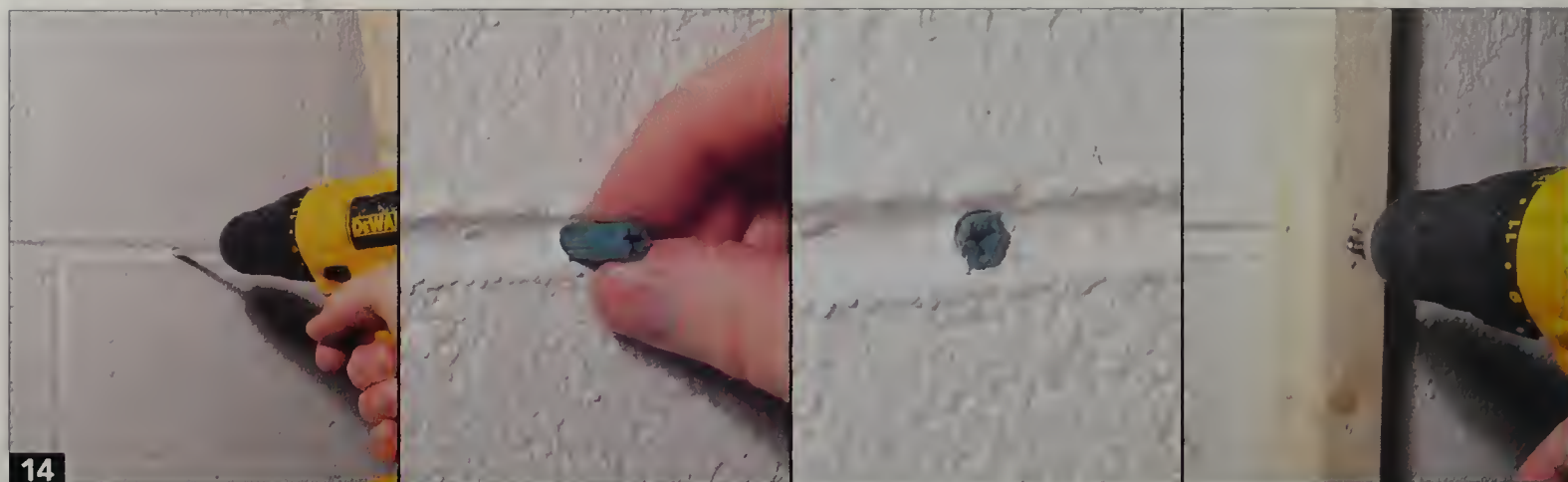


12



13

Anchor a vertical 2 x 2 to the wall with screws long enough to securely grab the stud. This is a 3" square-drive deck screw.



14

To mount a stud on a masonry wall, drill holes and place a masonry anchor or plug in each hole. The screws will expand the anchors and hold them securely in place.



15

Add the bracket arm. Make sure it's level as you add three screws through the arm into the stud.



16

With the 1 x 2 brace clamped in position on the arm, secure the brace at the base with a plywood gusset plate.



17

Screw the diagonal brace into place, making sure the arm is level.

Simple shelf brackets

For narrow shelf-style layouts, or sections of layouts, there's no reason to build full-blown benchwork. Instead, if your shelf is 18" or narrower, consider simple shelf brackets instead. You can see a simple bracket made from two 1 x 2s and a small plywood triangle brace in photo 9. This is especially effective for layouts featuring relatively level scenery, 10.

The design shown features a 12"-wide box frame made from 1 x 3s and topped with plywood ($\frac{3}{8}$ " plywood is more than sufficient for this design). The grid could also be left open for track on a grade. This design could be expanded to 18" with $\frac{1}{2}$ " plywood but make sure the plywood triangle is expanded to 12" on the right-angle sides. Be sure the screws holding the brackets are anchored to studs. One bracket every 32" (every other wall stud) will hold this framework.

You can also use commercial shelf brackets, 11. If the brackets are spaced every 18" (the standard spacing for wall studs), $\frac{5}{8}$ " or $\frac{3}{4}$ " plywood can be placed directly atop the brackets. I'd keep the shelf to 9" or narrower; any wider and a simple framework should be added. You can also use brackets like this with the box-grid design in photo 9.

Wall brackets

One of the most popular ways of building shelf-style benchwork is mounting brackets to vertical posts anchored to walls, 12. A 2 x 2 can be anchored to a finished wall, 13, or to a masonry wall. An advantage of this method is that the vertical posts also work well for supporting a backdrop later.

On a finished wall, make sure the screws go into a wall stud—I used the same 3" deck screws as in anchoring the

open-grid benchwork. Locate at least two anchors immediately above and below the bracket arm, with another screw at the very top and one about 9" above the floor.

On a poured-concrete or concrete block wall, use a masonry bit to drill holes for expandable wall anchors, **14**. Drill pilot holes in the 2 x 2 to align with these anchors and then screw the post into place. The screws expand the anchors, securing them tightly in their holes.

The bracket design in figure **12** can be adjusted for various widths. A 30" shelf depth is about the maximum for a comfortable reach. Mounting brackets every 32" to 48" is sufficient; if you're installing them in a finished room, you'll be limited by locations of the wall studs.

Install the horizontal bracket arms, **15**. Clamp the arm in place and drive one 2" No. 8 screw to hold it. Check the arm with a level to make sure it is horizontal and then add two more screws.

Add 1 x 2 angle braces from the base of the wall to each bracket, **16**. Make sure that the brace won't interfere with the L girder when it's installed. Cut the brace to fit, clamp the brace at the top, and use a gusset plate to secure the bottom. Screw the top of the brace to the bracket arm, again checking the arm with a level, **17**.

As you add additional braces, make sure they are level with each other. Check this with a long level or with a straight piece of 1 x 2 with a level atop it. You can see several brackets installed in photo **18**.

You may have to get creative in corners depending upon the wall stud locations, **19**. In this location, I joined one wall bracket to the first bracket on the adjoining wall.

Brackets can support butt-joint grids, **20**. Assemble the grids in the usual fashion and set them atop the bracket arms. The front face of the girder should protrude slightly from the end of the girder. Secure the grids to the bracket arms with short pieces of 2 x 2 screwed to the grid and arm.

For L girders, start by making the girders as in Chapter 3. With brackets spaced 48" or less apart, 1 x 2s are strong enough for girders. It's usually easiest to mount the girders under the bracket arms and then use the same



18

Several bracket assemblies are in place along two walls. Make sure the bracket arms align with each other.



19

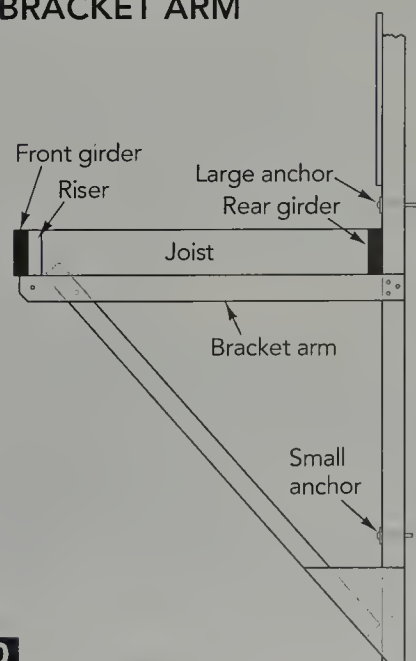
Wall stud placement will dictate where brackets can be located, so some creativity is often required in corners.

dimension lumber as the arms to make additional joists, **21**. The figure also shows how you can mount the girders above the arms.

Clamp a girder in place along the bracket arms, **22**. The flange should face the room on both girders to provide easier access for screwing joists in place. Remember the rule of fifths—each girder should be located one-fifth of the way in from each end of the arm. Screw the girders to the brackets from below. Since the girders are hanging from the brackets, use long screws—at least 1 3/4" or 2" No. 8 wood screws. To add stability and strength at the bracket joints, add additional 2 x 2 braces at every other bracket, **23**.

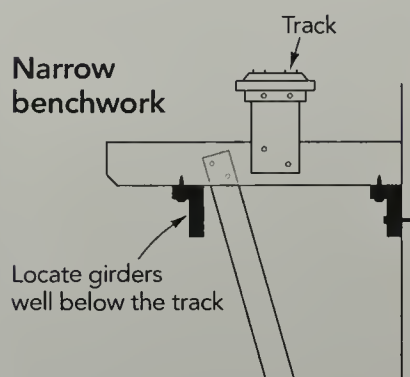
To join L girders at corners, cut away the flange on the girder that is joining the main girder, **24**. Add two screws

CROSS SECTION OF BRACKET ARM

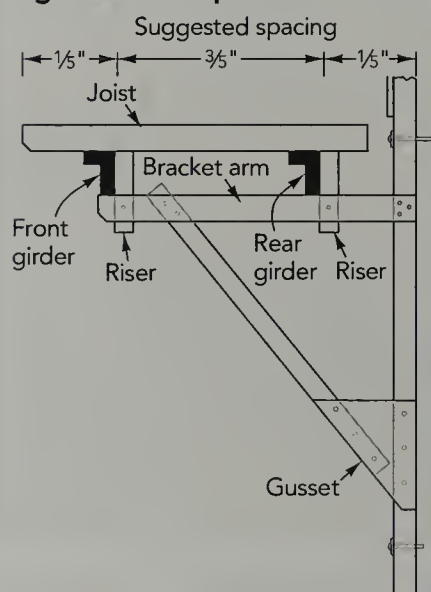


20

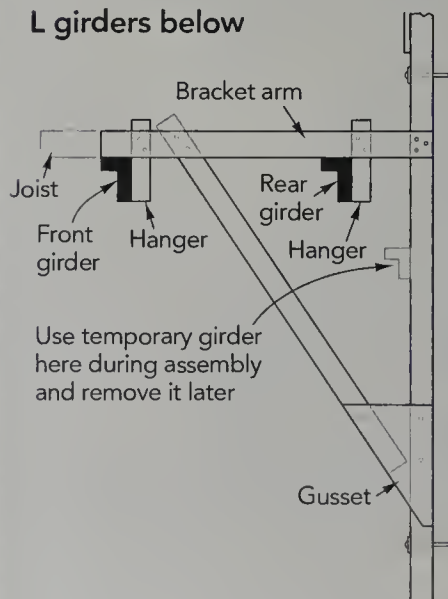
BRACKET SUPPORT OPTIONS FOR L-GIRDER BENCHWORK



L girders on top



L girders below



22 Screw the L girders in place under the brackets with long wood screws (at least 2" or 2 1/4").



23 Screwing a short 2 x 2 to the girder and bracket will strengthen the joint.



24 Cut the top flange from the two girders that are perpendicular to the original girder and then use a pair of screws to secure them.

through the web of the main girder to lock the girders together.

Add joists atop the girders as with conventional L-girder benchwork. Joists of various sizes can be added at differing angles in the corners, 25. The completed stretch is shown in photo 26. You can see how wide open it is under this 24"-wide layout. If you plan to add a backdrop, add horizontal 1 x 2 strips above the bracket arms and at the top of the 2 x 2s, as figure 20 shows. Chapter 10 explains how to install a backdrop.

Masonry wall alternate

Modeler Jim Six came up with another wall-bracket design for benchwork, which he mounted on both masonry and stud walls, 27. The 24"-wide brackets have 1 x 4s mounted vertically to the wall every four feet, with flat 1 x 4 bracket arms, braces at a 45 degree angle, and front board or fascia, 28.

Jim secured the brackets to the poured-concrete walls of his basement with a nail gun, 29. [Be sure to wear eye and ear protection when using a nail gun.] Jim then placed sheets of 2" extruded foam board into the framework, with additional scenery materials atop the foam. Conventional screws can be used with stud benchwork.

Foam shelves

Modelers have used sheets of extruded foam insulation for scenery since the 1970s. Bill Darnaby took this to a higher level in the early 1990s when designing his HO scale Maumee Route layout. Bill made the shelves themselves from 2" thick foam and mounted them on wooden brackets, 30.

Bill's layout has two decks, but the design works well for single-level layouts as well. He starts with vertical 1 x 2s mounted flat against the wall, spacing them 16" apart, 31. The brackets are 1 x 2 Ls, with the vertical 1 x 2 screwed to the side of the 1 x 2 stud. A 4" steel L corner brace stabilizes the bracket.

Bill reports that this design works for shelves up to 16" wide with no angle bracing. For shelves to 24", add a larger corner brace; for wider shelves, add the optional 1 x 2 brace shown in the figures.

The 2"-thick foam is then glued in place with latex construction adhesive. Add weights atop the foam until the



Joists can be positioned at almost any angle as needed around a corner, just like conventional L-girder benchwork.



Joists have been added to the girders. The benchwork is ready for roadbed.



This long stretch of benchwork is anchored to a poured-concrete basement wall with a nail gun. The recessed pocket is designed to hold a 2" sheet of foam insulation board. *Jim Six*



28

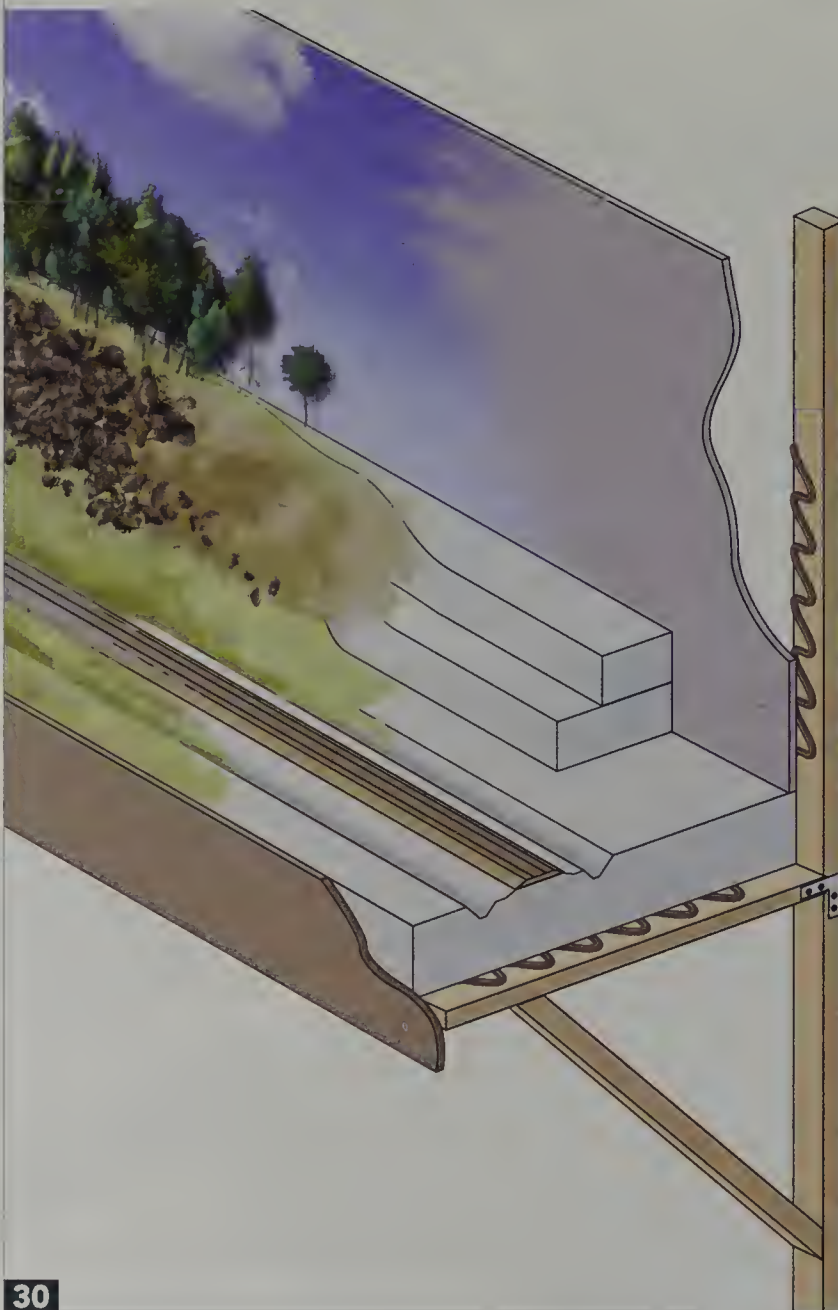
Each bracket has a 1 x 4 wall plate, a 1 x 4 bracket arm, and a 1 x 4 diagonal brace. *Jim Six*



29

Jim made quick work of securing the brackets to the masonry wall with a nail gun. *Jim Six*

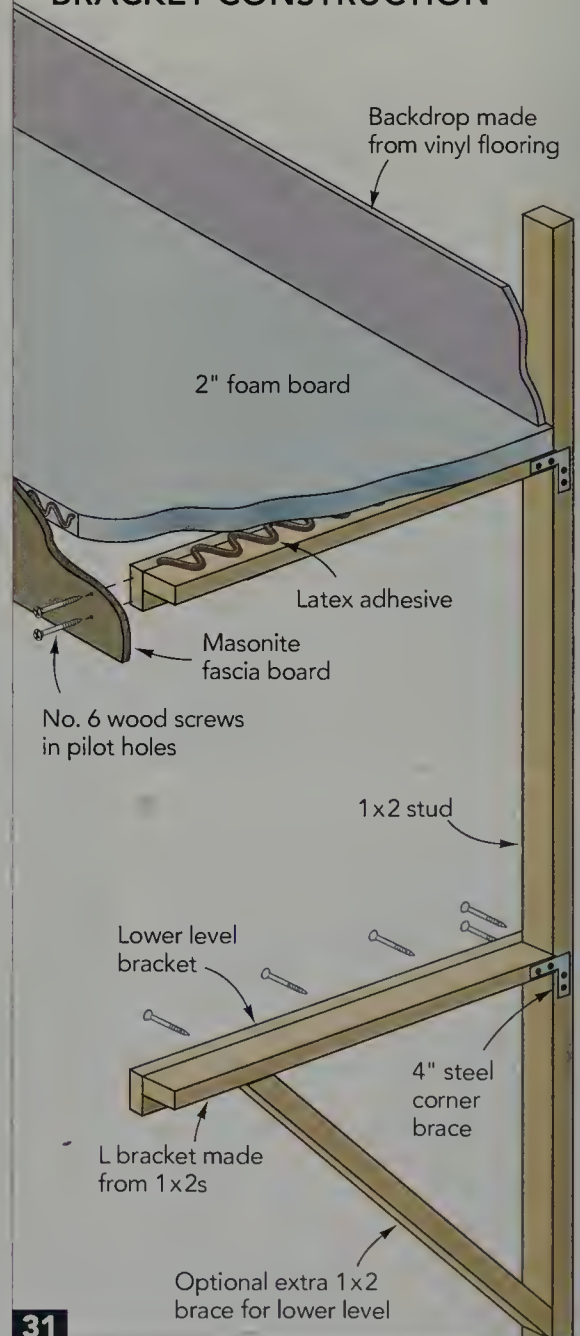
FOAM-BOARD CONSTRUCTION



30

This method of foam-board construction uses 1 x 2 L arms mounted on 1 x 2 studs. The foam is glued to the arms, fascia, and backdrop.

BRACKET CONSTRUCTION



31

The design works for single- or multi-level layouts.

glue dries. Make sure joints in the foam board are centered over a bracket arm. A cross section of a finished section is shown in photo 32.

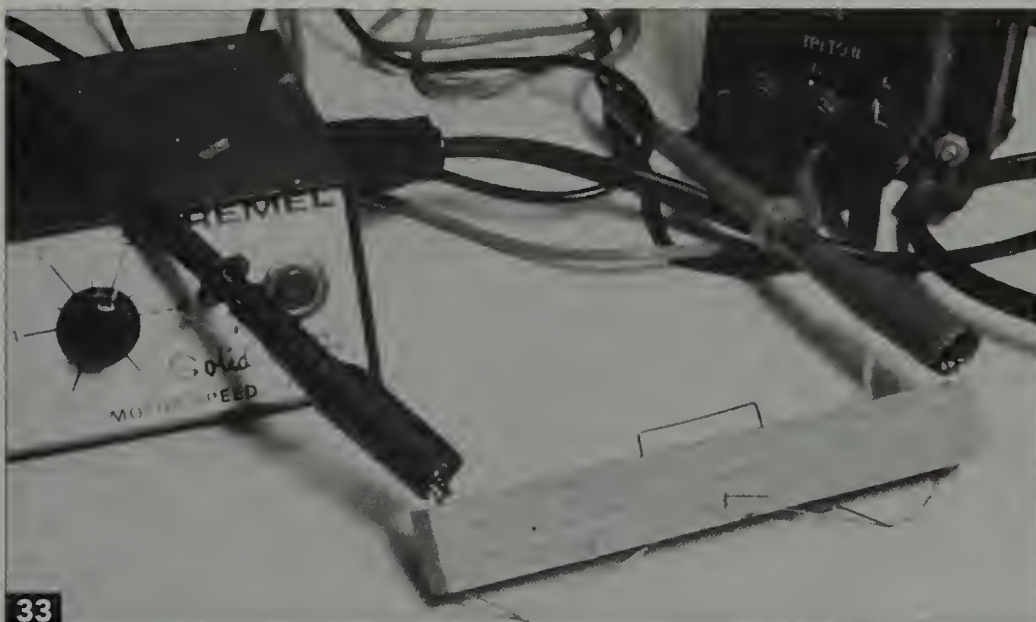
Bill creates ditches and other below-level features with a homemade hot-wire tool, 33. (Commercial hot-wire tools are also available from Hot Wire Foam Factory, Woodland Scenics, and others.) It is a power transformer from an Esico-Triton resistance soldering unit plugged into a Dremel motor-tool speed controller. Leads from the controller are clipped to wires in the shaping tools. A 10-volt, 3-amp setting works well.

The shaping tools are made by mounting .032" steel piano wire through holes in strips of hardwood approximately 1" square, 34. These allow cutting ditches and other features easily in one pass through the foam, 35. Bill shaped the ditch contour wires to match a prototype roadbed profile, 36. (Use caution when using hot-wire tools, as they become quite hot and can cause burns or fire if used improperly. Also provide adequate ventilation for the fumes and smoke that result from the process.)

Above-level features are added in conventional foam-scenery fashion by stacking additional layers of foam and carving them to shape. Underpasses, rivers, and other below-track features can be made by gluing an additional layer of foam below the main layer. You may have to adjust the bracket height to account for this, depending upon the length and placement of these items. A finished scene is shown in photo 37.



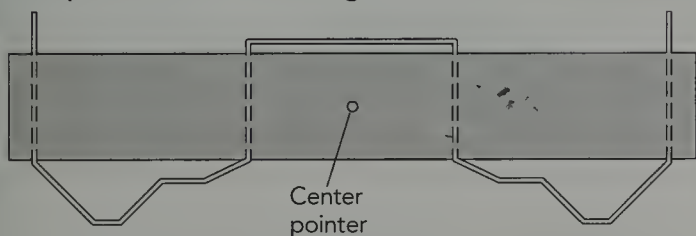
32 This cross section shows the ditches cut alongside the track and the cork roadbed. The fascia is screwed to the bracket arms. *Bill Darnaby*



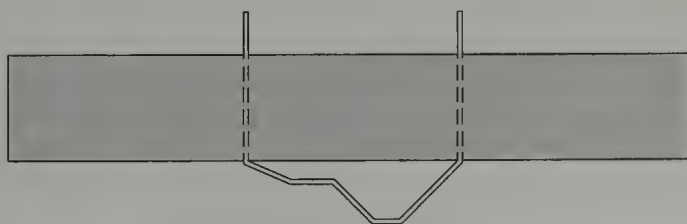
33 Bill made his hot-wire power supply by plugging a resistance soldering transformer into a motor-tool speed control. Alligator-clip leads connect the transformer to the hot-wire tool. *Bill Darnaby*

FOAM ROADBED CUTTERS

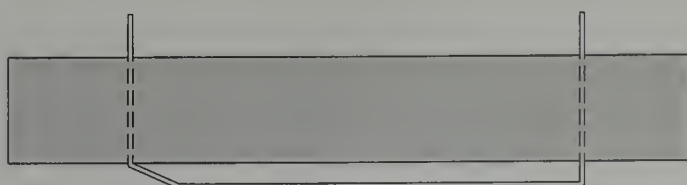
Full profile cutter for single main track



Half profile cutter for diverging and parallel tracks



Reducing cutter for lowering secondary tracks





35

The full-roadbed cutter is in the foam, and Bill has moved it along the right-of-way. *Bill Darnaby*



36

Here's the resulting profile cut into the foam. The lines mark a highway crossing. *Bill Darnaby*



37

The variations in ground level result in a realistic scene. Bill didn't use cork on this initial section. He chose to use it later to cut down on operating noise. *Bill Darnaby*

Steel benchwork

Steel studs have been popular for home construction for years, and modelers have begun using them for benchwork as well. Steel offers several advantages over wood. Steel studs are lightweight—about half the weight of a wood 2 x 4—making them easy to handle, and they're cost-effective, especially compared to select-grade lumber.

Most importantly, steel studs are dimensionally stable. Unlike wood, steel studs won't expand or contract because of temperature and humidity variations in your basement or layout room. Also, steel studs will always be straight. You don't have to search through a stack of lumber to find boards that aren't twisted and warped.

Modeler Art Jones opted for steel for his layout. His basic process for shelf-mounted steel benchwork is shown in photo 38. There are two main components: steel studs and steel tracks (U-shaped pieces into which the ends of the studs sit). The studs are 25-gauge steel, designed for nonload-bearing walls. All steel-to-steel joints are secured with self-tapping screws. If you're fastening a track to a wood-stud wall, use wood screws long enough to anchor securely in the studs.

Art reports that all self-tapping steel-stud screws are not created equal. Better-quality screws with sharp points work the best. Art opted for IBP (Itochu Building Products) screws purchased through a contractor's building supply service.

The benchwork itself is straightforward: one section of track is screwed to the wall. Studs are cut to the desired width of the shelf, and a second track caps the studs at the outside of the shelf. Additional studs are cut as angle braces running from the wall (screwed to wall studs) to the outer track every four feet.

Components can be marked with permanent markers for cutting, and heavy-duty tin snips work well for cutting the steel components to length. Be sure to wear gloves when handling and cutting the components and be careful of sharp corners.

As with wood benchwork, use a square and a level to make sure brackets and shelves are level and aligned properly.

Art and his friend Bill Boyd took the technique a step further, building a freestanding steel stud wall in the middle of the basement area and



This benchwork grid is made from steel stud cross members screwed to steel tracks. The braces are also steel studs, and the benchwork is topped with 1/4" plywood. David Popp

mounting the benchwork on either side of it, 39. Building the wall to the ceiling allowed adding a valance for lighting and provided support for a backdrop.

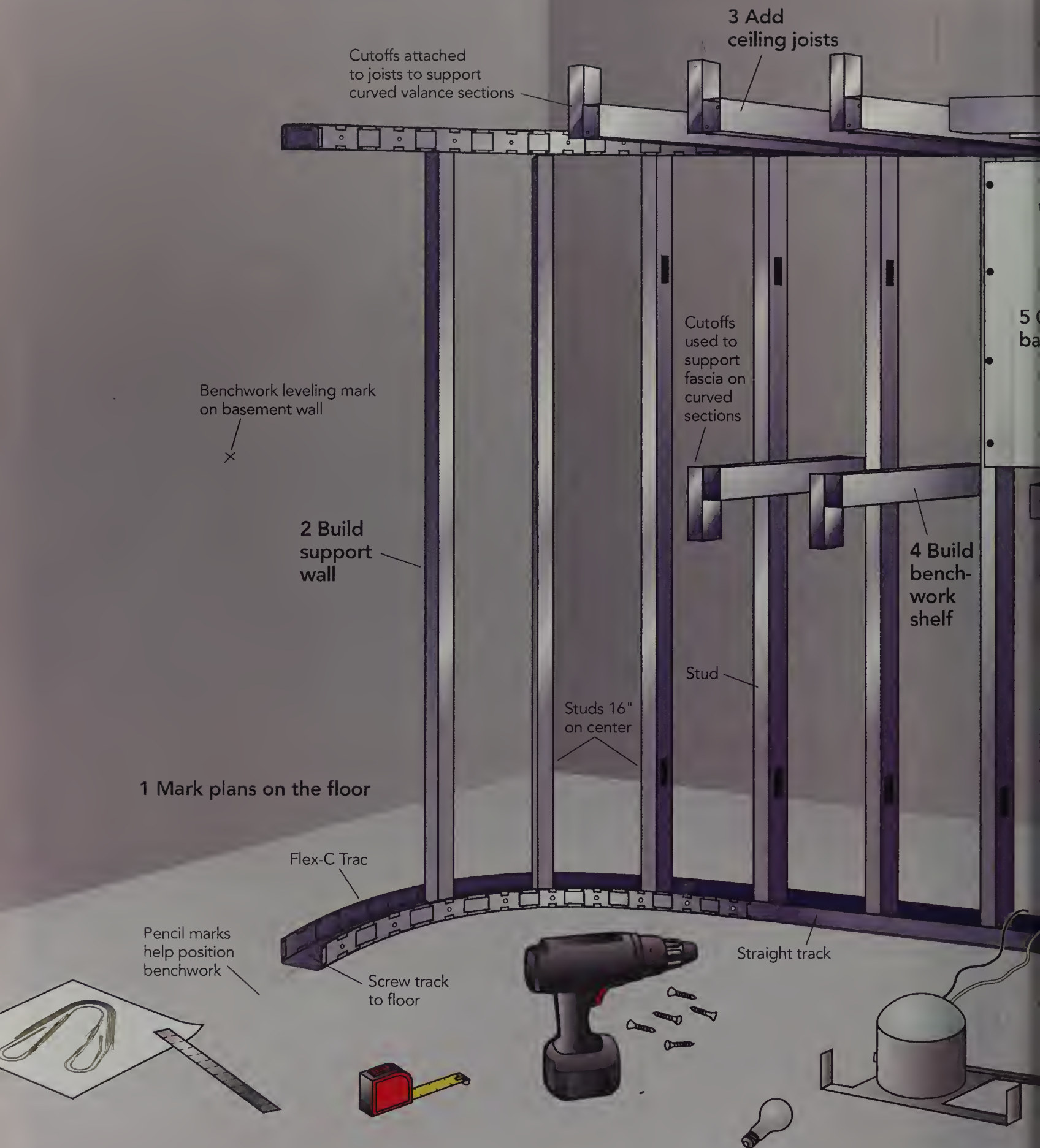
Flexible track (Flex-C Trac is one option, www.flexc.com) allows curved walls to be built without much more trouble than straight walls. The draw-

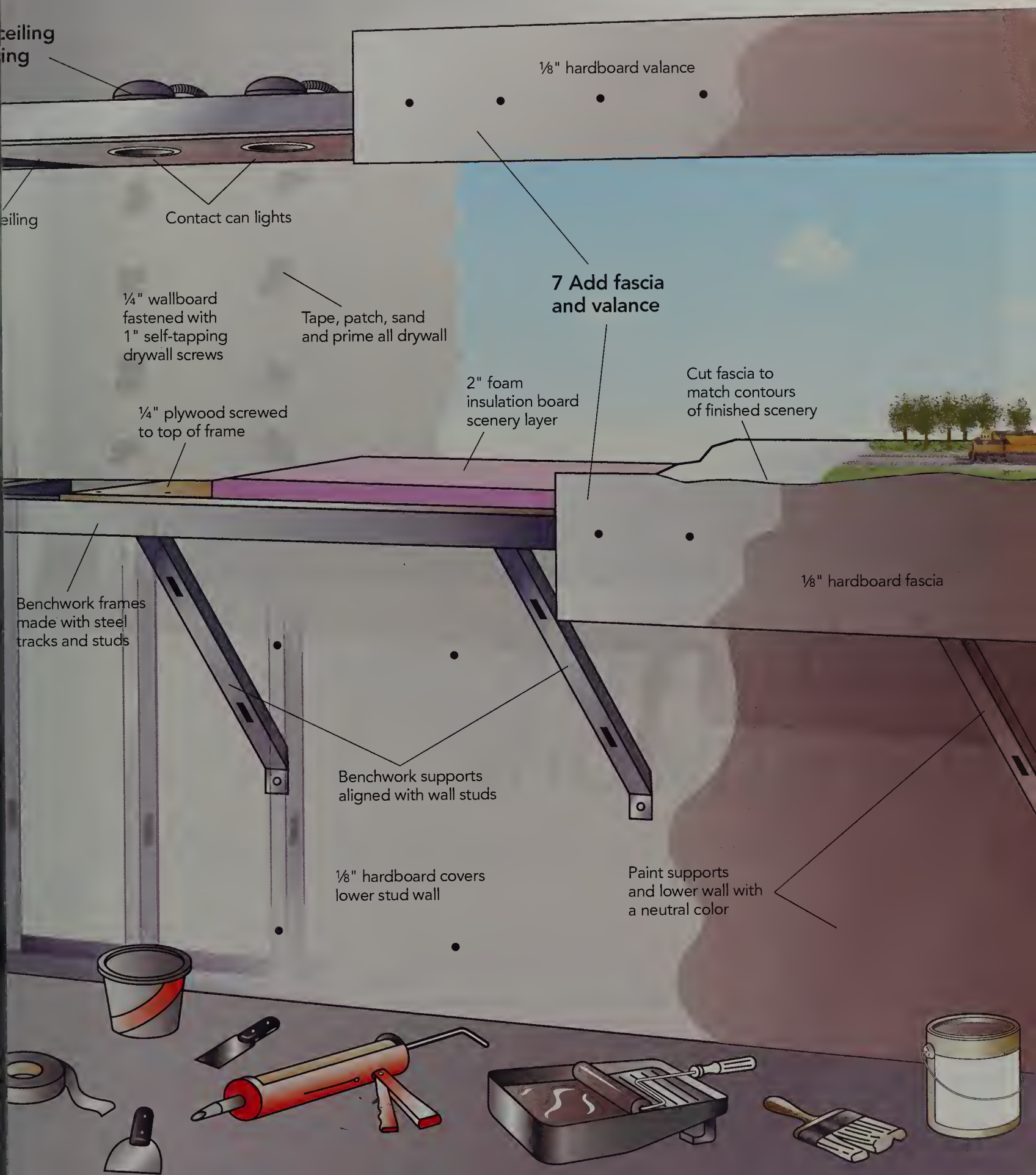
ing on the following pages shows the details and steps of construction.

Bendable drywall, a 1/4"-thick board made by USG and others, works well for curved wall surfaces.

If you would like more detailed information, Bill wrote an article on the process in the May 2005 issue of *Model Railroader*.

STEPS OF INSTALLING STEEL STUD WALLS AND BENCHWORK







Multi-deck benchwork

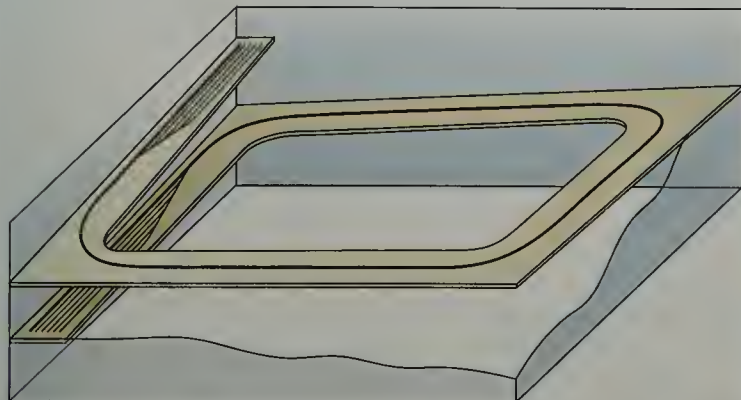
Expand your layout without expanding your basement

Adding a second deck can be a good way to extend the length of your railroad without taking up more floor space. This is Bob Foltz's 1951-era Santa Fe layout. *Bob Foltz*

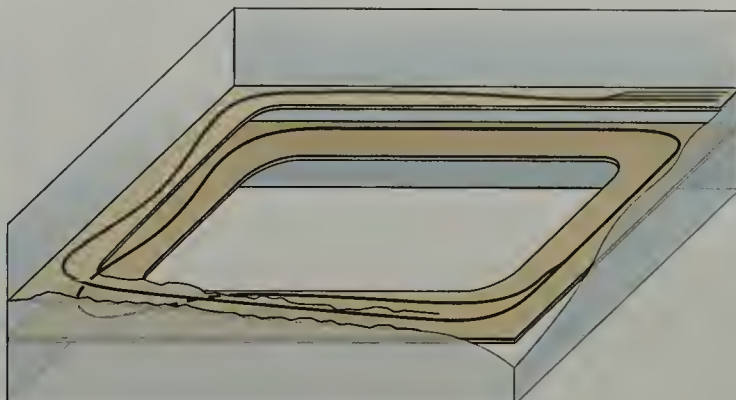
Probably the biggest reason modelers choose multiple-deck layouts is to get more railroading out of a given space. Adding a second deck can dramatically increase the layout area, and in some cases, makes it possible to nearly double the length of a main line, **1**. We'll look at several basic multiple-deck layouts, but for a more thorough look, see Tony Koester's book *Designing and Building Multi-Deck Layouts* (Kalmbach Books, 2008).

OPTIONS FOR TRANSITIONS BETWEEN DECKS

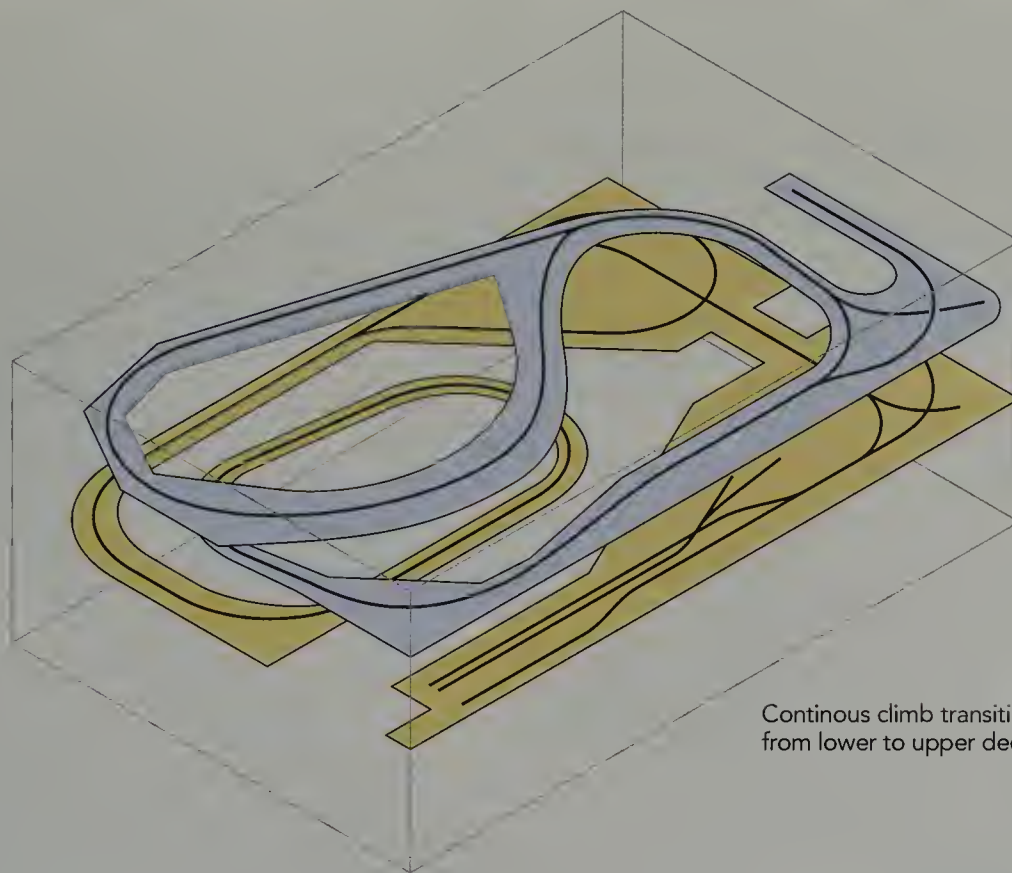
Partially double-decked layouts



Point-to-point around the walls



Continuous loop with branch line on upper level



Continuous climb transition from lower to upper deck

2

Although some layouts are completely double-decked, a much more common method is to double-deck only part of a railroad. The extra deck (upper or lower) can be a branch line, staging area, industry, or separate railroad. In the case of staging, the second deck is often hidden from sight on a lower level.

Before planning an extensive multiple-deck layout, consider the disadvantages to double-deck layouts. The first is increased construction complexity. Viewing angles are also a concern—adding a second level often means that neither level ends up at the

optimum viewing height. There's also a limited height to each deck. This isn't much of a problem if you're modeling the prairie, but it can be quite limiting if you're modeling a mountain railroad or a large city with tall buildings.

Some modelers have even gone to a third deck, but the logistics—such as deck heights and access—make it a construction and design challenge. It's certainly possible, but you need to look at the benefits vs. the headaches when doing so.

The biggest challenge tends to be getting trains to the second level, 2. One method with a point-to-point

layout is to start it along one wall and then have it gradually climb as it circles the room. The line becomes the upper deck when it completes the circuit. Another way to reach the second level is to climb on scenery until it reaches the height of the upper deck, 3.

Helixes—where track rises on a stacked loop from level to level—have long been used to move trains among decks, but they require a tremendous amount of space and can be difficult to build. We'll look at them in more detail in a bit.

A good rule of thumb is to keep the shelf of the upper deck at or less than



Track can gradually climb on scenery on the lower deck and then transition onto the upper deck as seen on Bob Foltz's layout. The narrow upper deck requires minimal support and doesn't interfere with lighting or scenery on the lower level. *Bob Foltz*

two-thirds the depth of the main level. This isn't an absolute rule, but doing so provides better access to the rear of the main level and less of a reach to the upper level. Another reason for a narrow upper level is that bracing for the upper deck must not interfere with scenery and operations on the lower level.

You also need to be aware of lighting. By following the two-thirds rule, enough light will usually reach the rear

areas of the main deck. If the upper deck is as wide as the lower one, it usually becomes necessary to provide additional lighting beneath the upper deck to light the lower level.

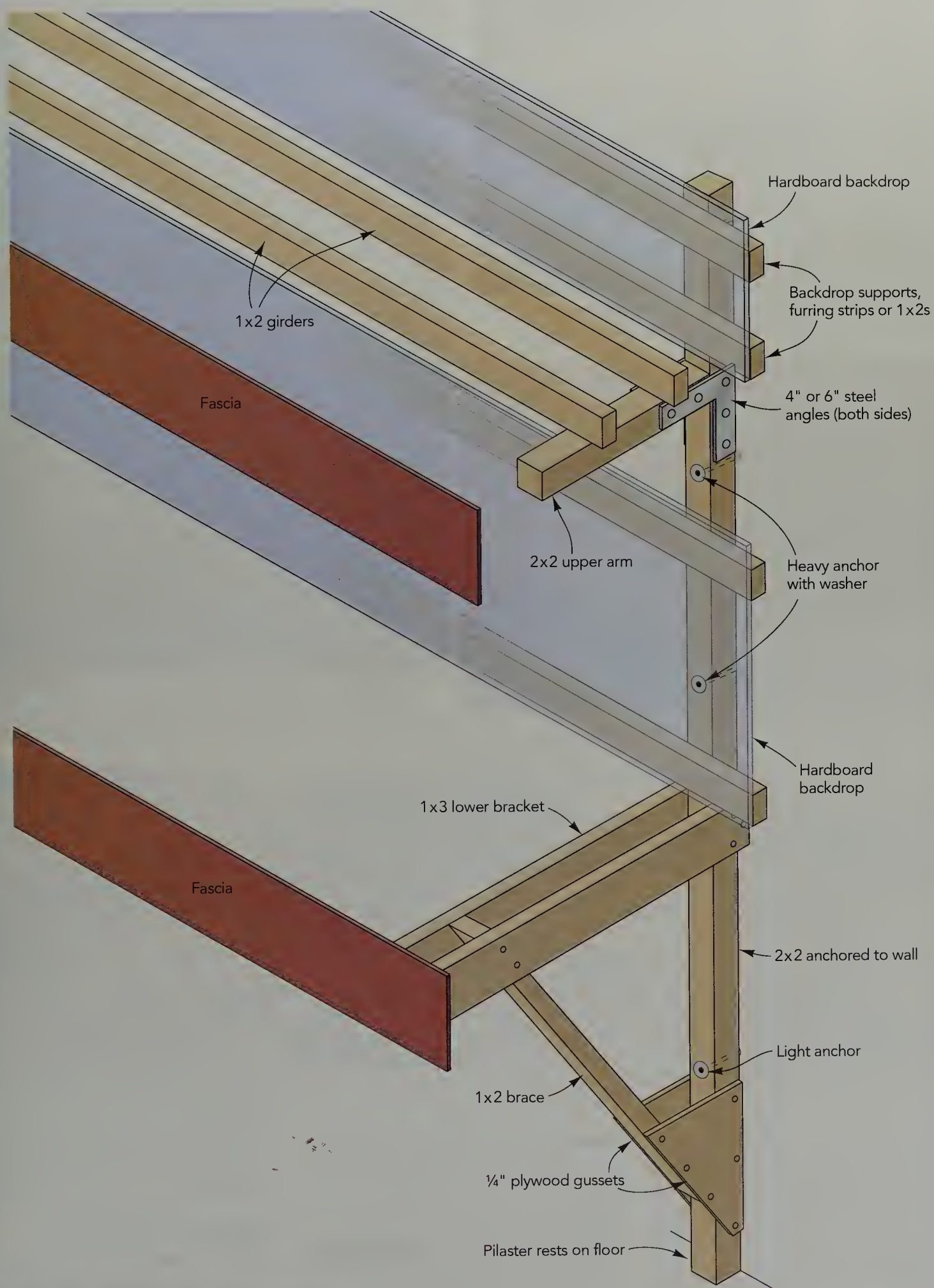
Basic two-level benchwork

There are as many ways to build multi-level benchwork as there are to build a conventional layout. The good news is that the basic shelf designs remain the

same, regardless of how many levels you have.

For a layout that gradually climbs, the challenge is in calculating the grade needed to provide adequate separation between decks. For example, let's look at an around-the-walls design in a 12 x 14-foot space. The bottom level will have a run of about 50 feet (600 inches) before it climbs to the point where it will become the

TYPICAL DOUBLE-DECK WALL BRACKET





5 Stamped steel L braces work well for supporting 2 x 2 brackets. Use an angle on each side of the bracket.

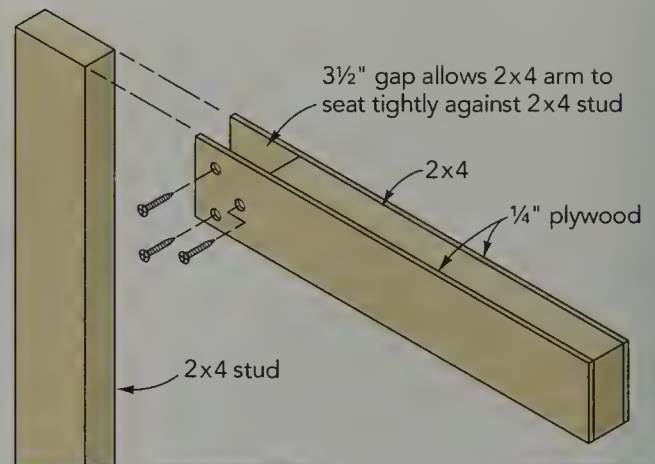


6 Don Meeker supports his layout's upper deck with brackets made from 2 x 4s and thin plywood. *Don Meeker*



7 Developed by Jim Murphy, this design has the 2 x 4 arm butted firmly to a 2 x 4 wall stud, with a plywood sandwich that is screwed in place. The design is quite stable. *Don Meeker*

MURPHY TRUSS ARM



upper deck. A 1 percent grade (1" of rise for every 100" of run) would only gain 6" of elevation—not nearly enough. Even 2 percent (considered a steep grade) would only gain 12", which results in a very cramped area on the first level.

Try to keep the track levels at least 18" apart between decks and more if possible to allow more scenery options. Keep in mind that even the thinnest upper-level benchwork will take about 3" of space, so an 18" track separation will leave only about 14" or 15" of open space on the lower deck.

One design option is shown in figure 4. It uses a vertical 2 x 2 stud attached to a wall, with lower and upper shelves both mounted to the post. The construction follows the designs from Chapter 6, with a wider lower shelf on L girders and a narrow upper shelf on a small bracket anchored by unobtrusive metal angle braces, 5.

If the vertical space is available, you can use a more heavy-duty self-supporting truss made by combining a 2 x 4 and plywood, 6. The builder of the layout in this photo, Don Meeker, used a design that his friend Jim Murphy developed: a 2 x 4 arm with 1/4" plywood on each side, screwed to a 2 x 4 stud, 7. This can be used on a single-deck layout as well.

The upper level can be a flat surface (foam or plywood), or an L-girder or box design following the narrow shelves shown in Chapter 6. Bill Darnaby's foam-shelf method was also designed as multi-level benchwork, 8.

Freestanding double deck

A double-decked peninsula or free-standing layout or layout section presents some unique challenges. One method is to build an open-grid or L-girder table with a series of vertical 2 x 2s or 2 x 4s down the middle, 9. The upper bracket arm can be a 1 x 3 with

up to 36" of length. If the top level is open with no backdrop, the 2 x 2 can be cut off at the top of the top bracket; if you need a backdrop, continue the 2 x 2 upward to support the backdrop.

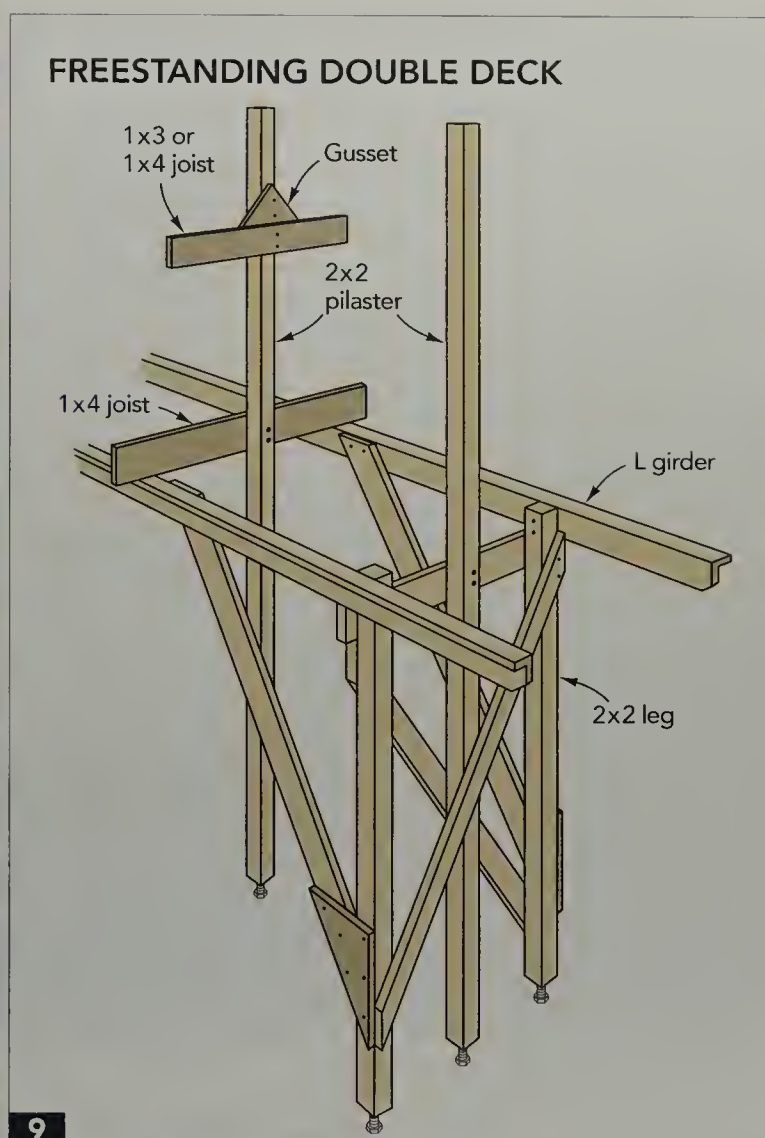
Jim Hediger's HO Ohio Southern has a double-deck peninsula that Jim built using an X-frame design, 10. Jim notched a pair of 2 x 4s to make the X-frame itself. The inside top of the frame is then notched for the upper L girders. As with conventional L-girder benchwork, the girders are strong enough to span 20 feet between supports. The result is an extremely strong layout that doesn't waste much space between the sides. Jim later added a backdrop to hide the frame on the lower level.

Helix pros and cons

A helix allows track to climb in a spiral from one level to the other—think of a coil spring, 11. The main advantage



8 Bill Darnaby's foam-shelf benchwork, shown in Chapter 6, lends itself well to double-deck construction. This is his HO scale Maumee Route layout. *Bill Darnaby*



9 You can build a double-deck freestanding layout with 2 x 2 center supports up the middle of conventional L-girder or grid table benchwork.



10 Jim Hediger uses a 2 x 4 X-frame design to support L girders on both decks of the freestanding portion of his HO layout. This allows a long span between supports. *Jim Hediger, both photos*



is that the helix takes care of the grade, instead of having the track gradually climbing on multiple levels. A helix can have as many loops as needed to make a climb—a three-loop helix has the same footprint as a seven-loop helix.

Helixes have two significant drawbacks: they take up a tremendous

amount of space, and they can be complex to build. Whether or not a helix makes sense for you depends on the shape of your layout space (Do you have a corner or odd space in which you could fit a helix?) and your overall room size (Are you willing to sacrifice the space required to gain another deck?).

The theme of your layout is also a factor. Are you modeling a flatland railroad? Then a helix might make sense, so you can keep the visible decks level. Do you model a mountain line? Then you might choose to have a steady upward grade starting on a lower level that winds its way around

the layout room to become the upper level.

Building a helix

Start by determining the clearance height needed. Find your tallest piece of equipment and add at least ¼" for a cushion. You also need to factor the height of the subroadbed (usually ½" plywood), track (⅛" to ⅜", which can vary by brand) and roadbed (⅛" for N scale cork, ⅜" for HO) if you use it. Use the chart for calculating the radius, grade, and resulting clearance.

The radius of the helix will need to be broader than the minimum radius of the equipment you use. A train traversing a full 360 degrees of curvature creates a lot of pull toward the inside, especially for long freight or passenger cars. Tack some flextrack to a piece of plywood and experiment if you're in doubt, 12.

The significant structure required for a helix is shown in photo 13. Jeff Johnston built an open-grid table to support the helix and then cut the roadbed from ½" plywood. The helix shown has a 27" radius (54" diameter), and has a 3" vertical clearance for equipment. The grade is just over 2 percent. Jeff saved some clearance space by eliminating roadbed and securing the flextrack directly to the plywood with No. 6 wood screws and No. 8 washers.

The complete description of Jeff's techniques can be found the April 2008 issue of *Model Railroader*, and he has since posted videos to YouTube showing the construction. Make sure your track is laid perfectly: you want flawless operation in a helix. You'll have to lay



This helix on Jim Hediger's Ohio Southern is located in one corner of his layout room. It loops around four times around a 66"-diameter circle to carry trains between decks. *Jim Hediger*

HELIX GRADES						
Amount of vertical separation		for grades of				
Radius/diameter	Circumference	1.5%	1.75%	2%	2.25%	2.5%
18"/36"	113"	1.7"	2.0"	2.3"	2.5"	2.8"
27"/54"	170"	2.6"	3.0"	3.4"	3.8"	4.3"
36"/72"	226"	3.4"	4.0"	4.5"	5.1"	5.7"
48"/96"	301"	4.5"	5.3"	6.0"	6.8"	7.5"

To calculate the circumference of a circle, multiply its diameter by pi (3.14). The grade percentage is the amount of rise (separation) divided by the length of run (circumference).

the track as you build the helix from the bottom up, because once you start a new level, laying track on the earlier level will be next to impossible.

Get the proper grade on the first loop, making sure it's consistent through the entire circle and then use spacer

blocks of a consistent thickness to keep the grade going for successive levels.

As with conventional benchwork, there are commercial options as well. Check out Easy-Helix (www.easyhelix.com) and Ashlin Designs (www.ashlintrains.com) to see examples.



Before building his helix, Jeff Johnston checked the clearance needed for his equipment to clear spacer blocks at the required radius. This is especially important if you're building a double-track helix. *Jeff Johnston*



Jeff built a grid table of 1 x 4s with 2 x 2s to support the helix. The roadbed is ½" plywood with 3"-wide spacer blocks between levels. Flextrack is screwed directly to the plywood. *Jeff Johnston*



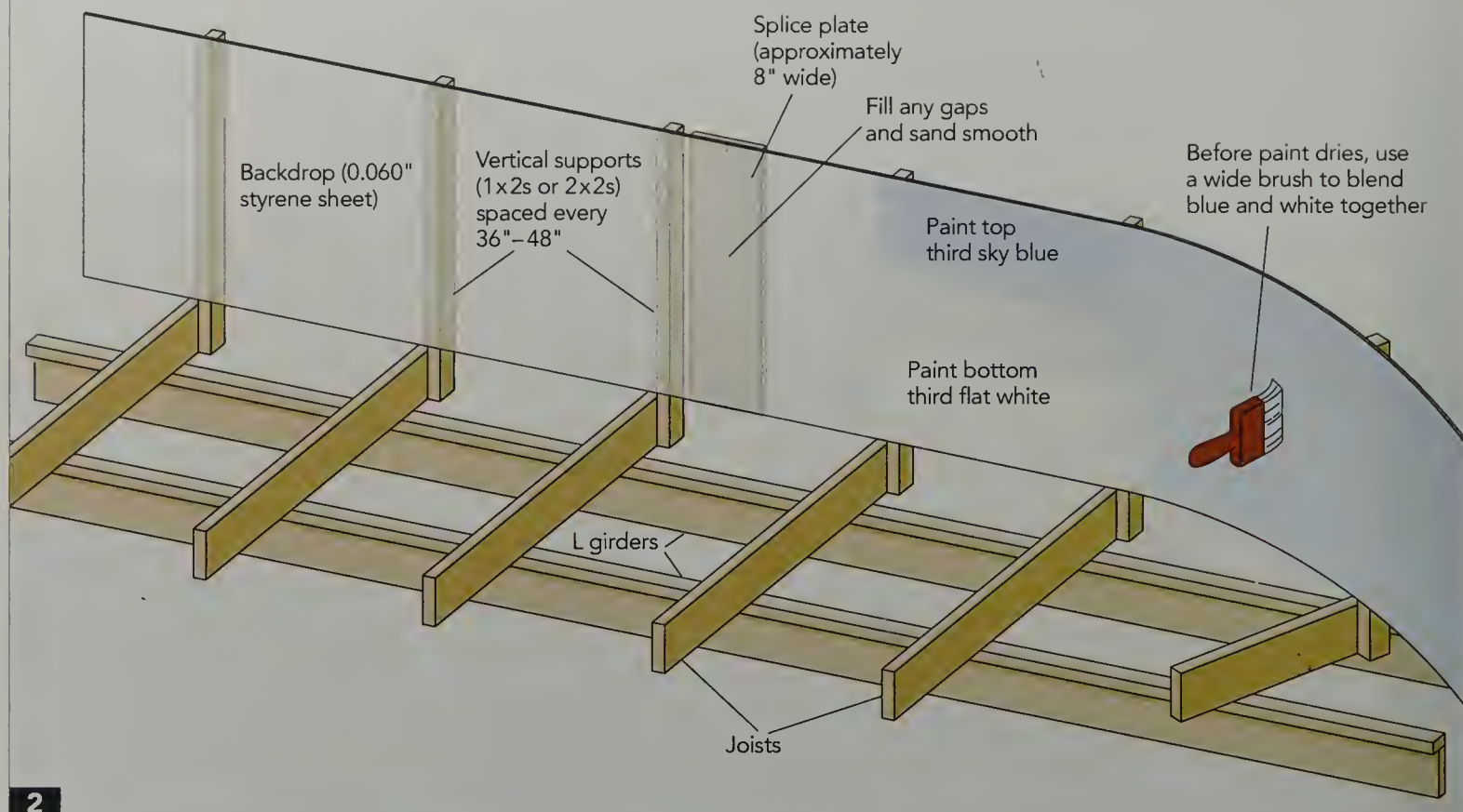
Backdrops and fascia

Visually extend your layout

A backdrop is one of the most important scenic elements you can add to a layout, **1**. It takes up little room along basement or room walls, but it can visually extend a layout for miles. Backdrops are extremely easy to add to an around-the-walls layout, and with proper planning, they can be used on freestanding layouts as well. The key is to add the backdrop when you build a layout. Adding a backdrop after the scenery is in place is difficult to do without damaging the scenery.

This section of Rick Rideout's HO Louisville & Nashville layout is on a narrow shelf, but the backdrop helps make the scene look much broader. Notice how the fascia helps frame the scene and follows the contours of the scenery.
Rick Rideout

BASIC BACKDROP CONSTRUCTION



2



3

Screw horizontal supports (1 x 2s or furring strips) in place to hold the backdrop.

Fascias are also important. A fascia helps define the lower edge of a scene, makes a layout look clean by hiding supporting benchwork, and provides a place to hang throttles and mount switches and controls.

Painting and detailing a backdrop are beyond the scope of this book, but when you reach that step, I recommend Mike Danneman's book *Painting Backdrops for Your Model Railroad* (Kalmbach Books, 2008).

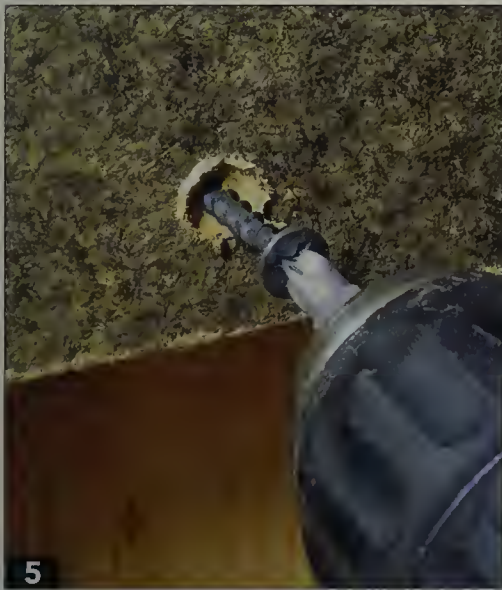
Installing a backdrop

The basic technique of adding a backdrop is shown in figure 2. Start by adding a series of vertical 1 x 2s on the wall or at the rear of your benchwork. You can simply attach the backdrop to these, but you may find that the backdrop develops undulations between the supports. Adding horizontal strips (1 x 2s or furring strips) will provide a more even base for the backdrop, 3.

The most common material modelers use for backdrops is tempered hardboard (Masonite is one brand). It's an excellent choice since the 1/8"-thick material is smooth, resists warping or flexing once it's mounted, is easy to handle, and is easy to curve around corners. The sidebar on the opposite page describes backdrop (and fascia) materials.



4 Clamp the first section of hardboard in place. The backing plate is a 1 x 4 that is screwed in place between the horizontal supports at the backdrop joint.



5 Countersink a hole in the backdrop. Be careful not to drive the screw completely through the thin hardboard.



6 Clamp the second sheet of hardboard in place, so it butts tightly against the previous piece, and make sure it is level.

Backdrop and fascia materials

You have several choices for materials when constructing backdrops and fascia:

- **Hardboard.** Tempered hardboard, $\frac{1}{8}$ " thick, is a popular material for backdrops and fascia. It can be cut with a saber saw and easily curved around corners.

- **Sheet styrene.** Sheet styrene, .060" or .080" thick, works very well for backdrops. You can buy it in 4 x 8-foot sheets from plastics dealers in medium-size and larger cities. Install it like hardboard but use a splice plate of thin (.005" or .010") styrene sheet at each joint. Glue joints with plastic solvent and fill any gaps with plastic putty. It can be painted with ordinary latex paint but be sure the surface is clean before painting.

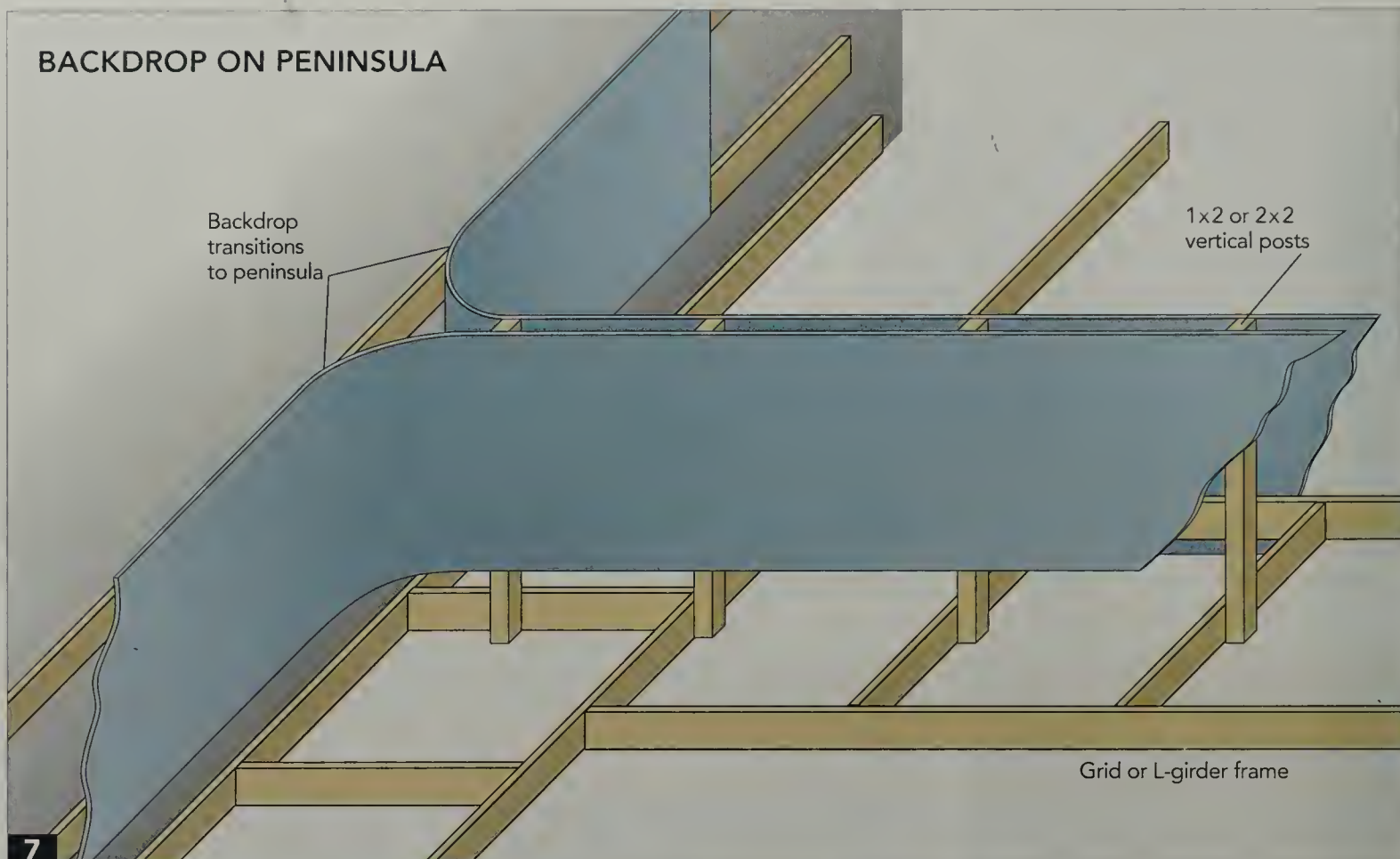
- **Drywall.** Drywall comes in 4-foot-wide sheets in 8-, 10-, 12-, and 14-foot lengths. One problem

is that if you turn the sheet on its side you lose the beveled edges that make it so easy to join. Drywall's biggest limitation is corners—it can't be bent to a tight radius—so you'll need to use a different material to form corners.

- **Plywood.** Thin plywood can be used for a backdrop, but the wood grain tends to show through paint, even with high quality (A-grade) material. Plywood is almost impossible to bend into corners.

- **Vinyl flooring.** This material comes in wide rolls, but narrower cutoffs can often be purchased quite inexpensively from flooring stores. The color, pattern, and design don't matter—mount it with the smooth underside facing outward. You can cut it with a utility knife. Forming joints can be difficult, so try to find cutoffs long enough to eliminate joints.

BACKDROP ON PENINSULA



The backdrop can extend several inches above the top frame without fear of sagging, and the bottom support can be 5" or 6" above the bottom of the backdrop. For the best appearance, make the backdrop as tall as possible. It should extend from the layout to the ceiling, if possible. Any open area between the top of the backdrop and the ceiling will be distracting, and it's no more difficult to install a 36"-tall backdrop than a 24" one. If your backdrop is 36" or taller, add a third 1 x 2 horizontal support down the middle.

Cut the hardboard to the desired width with a table saw. If using a hand-held circular saw, cut it with the face of the hardboard down for a clean cut. This is a dusty process so do it outside if possible. (Some lumber dealers will also make cuts for you for a small fee.)

Plan sections so that no joints occur in corners. Make sure that the ends of each section are cut clean and square and then clamp the first section in place, 4. Note the 1 x 4 backing plate behind the joint—this will provide stability when filling the joint later. Check the end of the backdrop with a level, making sure it is perfectly vertical.

Attach the hardboard to the 1 x 2s with $\frac{3}{4}$ " flathead wood screws or coarse-thread drywall screws, 5. Drill counter-



Backdrops can disguise hidden tracks. Make sure you have access to the track or keep the backdrop low enough to reach over if necessary.

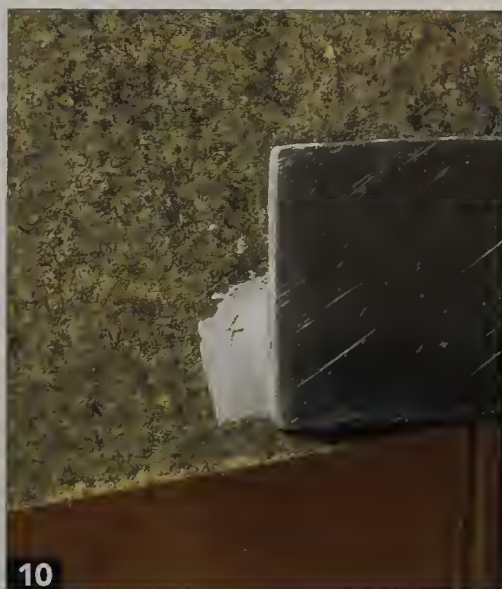
sunk pilot holes in the hardboard (being careful the wide portion of the bit doesn't go completely through the hardboard) to make sure the screwheads will be below the surface of the hardboard.

Add screws about every 8" along the top and bottom support pieces, but don't yet add the screws at the joint. Release

the clamps at the splice plate, spread a coat of carpenter's glue under the hardboard, and reapply the clamps. Gluing the backdrop to the backing board makes it easier to get a clean joint and minimizes the chance of a joint cracking later. Add screws down the splice plate and then remove the clamps again. Use



9 Clean fuzzy edges at the seams between backdrop sections and around screw holes with a sharp knife.



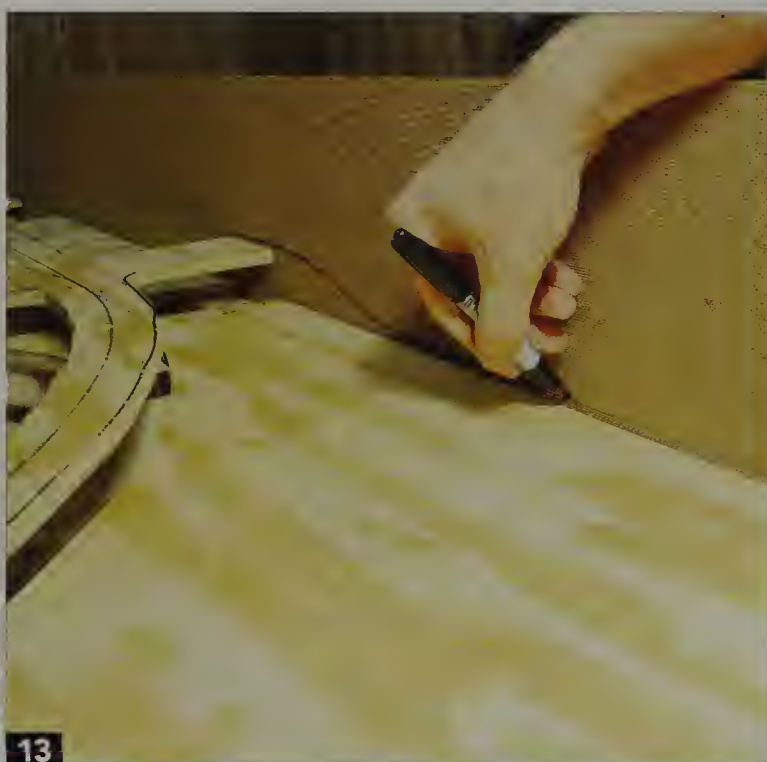
10 Apply spackling compound to screw-heads and seam joints with a putty knife. Use multiple coats if necessary.



11 A fine drywall sanding sponge works well for smoothing the filler material.



12 Clamp the hardboard fascia in place on the edge of the benchwork.



13 Mark the scenery contour on the back of the hardboard with a felt-tip marker.

a damp cloth or paper towel to remove any glue that oozes out.

Butt the next piece of hardboard tightly against the first. If the piece is to go around a corner, clamp it on that end and then keep forming it around the corner, clamping as you go, **6**. You can make the corner as broad as you wish—mine has about a 12" radius.

Coming out of the corner, make sure that the backdrop is level and continue clamping it until the end of the piece. Check that the end is perfectly vertical and add another splice plate at the end.

Once the backdrop is aligned, release the clamps at the end where it meets

the first piece. Pull up the hardboard, spread glue on the splice plate, and press the hardboard back in place. Screw the backdrop into place as with the first piece. Continue the process until all of the material is mounted.

You may have to get creative when mounting a backdrop on peninsulas or freestanding tables, **7**. You can usually place a backdrop on supports down the center of the table.

Backdrops can also be set in from the rear of benchwork to block the view of hidden track, **8**. Be sure you have access to the track when designing an area like this.

Once the backdrop is in place, begin cleaning and filling the screw holes and joints. Use a hobby knife to trim any loose fibers from the hardboard around the screw holes and joints, **9**. Spackling compound works well to fill the screw holes and cracks. Apply it with a putty knife, **10**.

Don't try to do this with one coat. Instead, apply a coat, let it dry, sand any high spots, and add another coat. Repeat this until the area is smooth and fill joints in the same manner. A drywall sponge sanding block works well for sanding the spackle at the joint, **11**.



14 Cut the fascia along the marked line with a saber saw.



15 Clamp the cut fascia back in place along the layout's edge.



16 Wood screws with finishing washers are a good choice if you don't need a perfectly smooth finish.

Apply a coat of latex primer (a roller works well for this) before painting your final sky color on the backdrop. If any screwhead or seam marks show through the primer, sand the area and reapply spackle until the area is smooth.

Adding fascia

A fascia, or front (facing) board, greatly cleans up the look of a layout. Painted fascia looks much neater than bare wood or the edge of scenery. The fascia is also a great location for electrical switches, throttle jacks, throttle holders, holders for car routing cards, and small control panels.

Once again, hardboard is probably the most popular choice: it's durable, relatively inexpensive, easy to cut, smooth, and easy to paint.



17 The fascia and backdrops are in place on this section of a double-deck, wall-mounted layout.



Fascia can smoothly follow the contour of the layout, as on Mike Danneman's N scale Rio Grande layout. *Mike Danneman*

Having the top of the fascia follow the scenery contour provides a clean, neat look. A good way to do this is by adding the fascia before building scenery and then building the scenery to the fascia contours. If you're not sure exactly how the contour will go, you can add the fascia after the scenery is in place.

The first step is to provide a solid mounting area for the fascia. This can be done in different ways, depending upon the benchwork method used. You can mount it to the facing 1 x 3 or 1 x 4 of grid benchwork or to the joist ends of L-girder benchwork. The bottom of the fascia can hang several inches below the bottom support.

Fascia depth is largely a matter of taste. It should be deep enough to hide all of the upper benchwork components such as joists and to hold all the controls and features you want. But don't make it so deep that it restricts access under the layout.

Clamp the fascia material in place, 12. Trace the scenery contour onto the back of the fascia, 13. If the scenery is in place, this is very easy. If the scenery isn't in place, it's best to guess a little on the high side so you can trim it lower if necessary.

A saber saw works best for cutting hardboard, 14. Cutting it with the back side toward the saw makes for a clean cut on the face, since a saber saw cuts on the upstroke.



The curved fascia gives a nice flowing look to the peninsulas on Monroe Stewart's N scale layout.

Clamp the contoured fascia in place, 15. You can install it with countersunk screws, as described in the section on backdrops, and fill the screw depressions with spackling compound. A simpler method is to use wood screws with finishing washers, 16. These provide a neat look and are a good alternative since fascia doesn't require a perfectly smooth surface as does a backdrop. You can see the fascia and backdrops applied on a section of double-deck layout in photo 17.

The fascia can flow in curves around corners and peninsulas, 18. If the lengths of your joists vary, the fascia

will curve along to match. You can also add extensions to joists to push the fascia out where needed. Another good example of this is on Monroe Stewart's N scale layout, 19.

You can simply leave the area under your layout open for access and storage, but adding a curtain will make the area look much neater. Black muslin fabric can be cut to match the height needed. It can be held in place by hook-and-loop fasteners (such as Velcro) or by spring-type clothespins hot-glued behind the fascia. Keep the curtain to short lengths (48" or so) to make it easier to get under the layout.

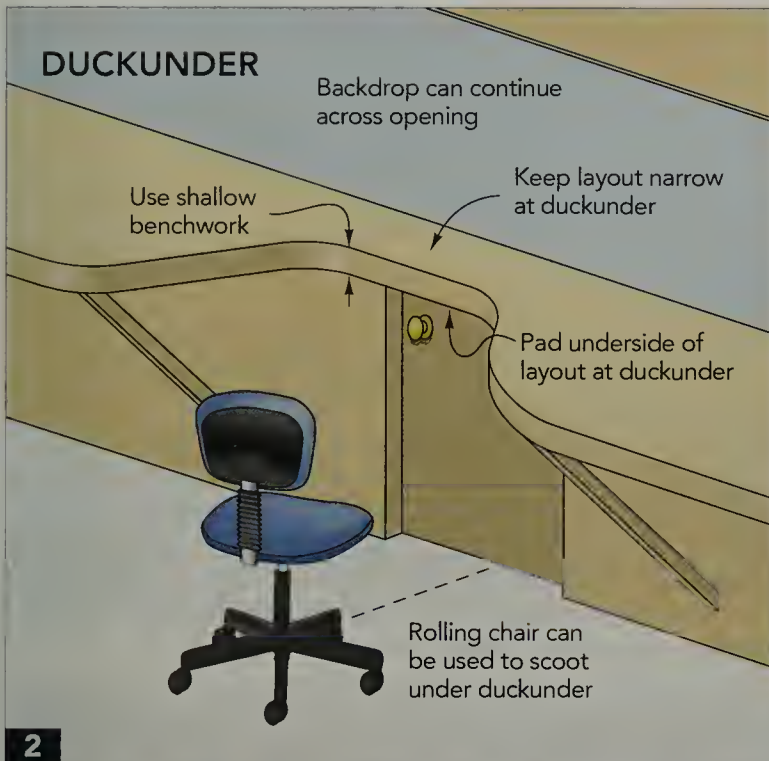


Duckunders, liftouts, and swinging gates

Options for gaining access to your layout

A liftout section, such as this one, provides a clear path through the only doorway into the layout room. It only takes a few seconds to remove or replace the liftout, making the railroad ready for operation.

Most track-planning guides recommend avoiding duckunders, liftouts, and swinging gates if possible, **1**. However, we've all discovered at one time or another that to get optimum use from some spaces, we sometimes have to locate the track across a door opening or other walkway.



The wall-mounted, open-grid benchwork was built to either side of the doorway, with a 1 x 4 face on each side.



Cut the plywood for the liftout, so there is a narrow gap at each end.



A 1 x 2 across each end provides mounting pads, and the lengthwise 1 x 2 doubles as a brace and handle.

To duck or not to duck

Should you leave an area as a duck-under? That depends upon how much ducking you'll have to do. Is an area the only access to the layout area or is it a path used less often? If the bottom of the frame is fairly high (50" or taller), and you and your operators are under 6 feet (and reasonably young and in good health), ducking might not be too cumbersome, **2**.

There are a couple of big advantages to duckunders. First, having one allows benchwork to be continuous, with no worries about track alignment, as with gates or liftouts. Second, a duckunder allows seamless scenery and backdrops, with no breaks at the opening.

However, remember that the older we get, the less agile we become. And, especially when dealing with the main entrance to the layout, the annoyance of a duckunder could eventually diminish your overall enjoyment of the hobby.

If you do choose a duckunder, here are some tips to keep in mind:

- Keep the layout at the duckunder area as narrow as you can (no more than 16" if possible). The wider the duckunder is, the more likely it is that someone will stand up too soon and bump it.
- Make the space under the duckunder as tall as possible. Using a 1 x 2 frame at that spot instead of 1 x 4 will save almost 2" of height.
- Pad the edges and underside of the

duckunder, especially the edges. Use rigid foam insulation, foam rubber covered with cloth, or another soft material. Be more concerned with safety than aesthetics.

- Bundle all wiring and fasten it securely under the layout, so nothing is hanging down.
- Brace the layout especially well at both ends of the duckunder area. Eventually you—or one of your crew—will hit your head or back on it, possibly with great force. Make sure everything is anchored to prevent damage or shifting of the layout.
- Label the area well to make sure people know that is where they're supposed to enter and leave the layout.



6 Screw a steel shelf mounting peg into each corner of the liftout section.



7 Clamp the 1 x 2 supports in place at each end of the benchwork. The ends have been rounded with a rasp and sanded.



8 Mark the bottom of the each mounting pin with a pencil.



9 Carefully align the liftout and press it firmly in place.

One way to make a duckunder less cumbersome is by using a rolling chair: leave a chair with casters on it (such as an old office chair) at the duckunder location. As operators come and go, they can sit down in the chair and roll themselves under the duckunder, with minimal or no ducking required.

Liftouts

If you decide the access area needs to be moveable, a liftout section is the easiest way to go. A liftout can be shallow in profile, so you can leave it in place most of the time and simply duck under it unless you really need to remove it. Here are a few critical things to consider when building liftouts:

- Keep the span as short as possible.
- Keep the design simple. The more complex it is, the more likely something will get knocked out of alignment.

- Avoid turnouts on the liftout.
- Have straight track at both ends. While 90 degree joints are best, angles can still work well.
- Use care in lifting and replacing the section. Regardless of how sturdy the liftout is, the track can easily be dinged and knocked out of alignment. Have a designated spot next to the access area to place the liftout when it's removed.
- Always, always, always check the track alignment every time you lock the liftout in place.

There are many ways of building liftout sections. The following steps show one design that worked for my home layout (shown in photo 1), but feel free to come up with your own designs and modifications. The layout was in a bedroom with the liftout needed across the only doorway, 3.

Make sure that both ends of the layout connected by the liftout are firmly anchored. Use a level to make sure that both ends are in alignment. On a freestanding layout, secure the legs to the floor on each side.

The base for the liftout is a piece of $\frac{5}{8}$ "-thick plywood. A $\frac{3}{4}$ " piece is more solid, but it is also heavier, so I went with the lighter and easier to maneuver size. Don't use dimensional lumber: it's too prone to warping and cupping as well as changing size along its length from humidity variances. Cut the piece to fit. Mine is 6" wide—you'll have to adjust the dimensions to fit your application. The gap between each end and the subroadbed on the layout should be about $\frac{3}{32}$ ", 4.

A 1 x 2 glued and screwed across each end provides a stable base, and a lengthwise 1 x 2 down the middle of



10

The pencil marks will be transferred from the pins to the supports.



11

Drill a hole at each pin mark using the marks as guides. Use a drill press if possible.



12

Widen each hole at the top. A T-handle reamer does this job well.



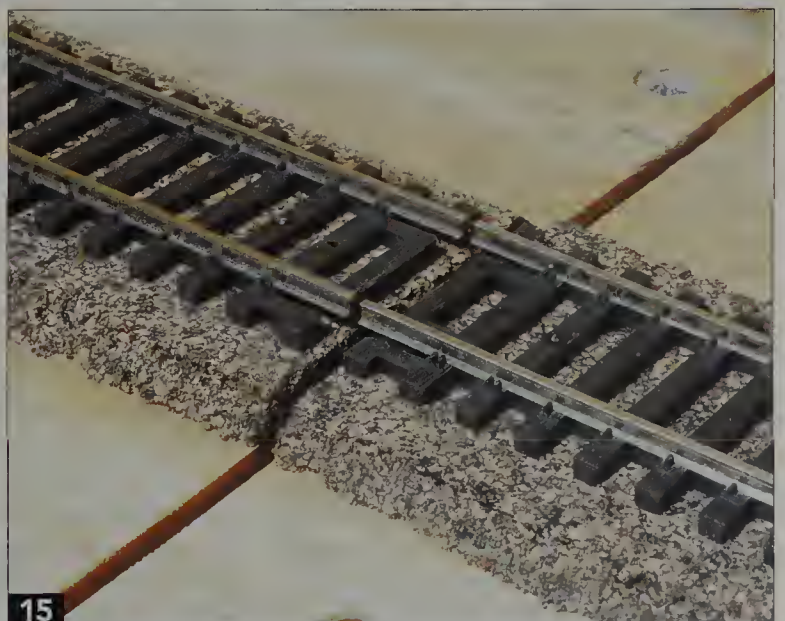
13

Press the liftout onto the supports and align the assembly. Clamp the supports in place.



14

Screw the supports in place, countersinking each mounting hole. Hook-and-eye connectors secure the liftout firmly.



15

Lay the track on the liftout and each end of the layout. Leave a $\frac{1}{16}$ " gap between rail ends.



16

Mount a push button at the proper height so that the liftout will trigger it when in place. An old cabinet magnet case houses the button.



17

Track power can be routed to the liftout by any type of two-connector plug and socket.



18

This curved liftout section on Bill Darnaby's HO layout is simply $\frac{3}{4}$ " plywood held with magnetic latches. *Bill Darnaby*

the bottom provides longitudinal strength and serves as a handle for grabbing the liftout, 5. Round the corners of the lengthwise 1 x 2 with a plane or Surform tool and sand all corners and surfaces on the plywood and 1 x 2s to eliminate any chance of getting splinters while handling the piece.

Steel shelf pegs with mounting angles work well as locating pins. I used $\frac{1}{16}$ "-diameter pins, but you can change this based on what you can find at your local hardware or building supply store. Mount a peg at each corner, 6.

A 1 x 2 will support the liftout on each side of the opening, 7. Cut them

to length to match the opening. Round the ends of these pieces by cutting them at an angle and shaping them with a Surform and sanding block. Clamp them into place.

Mark the locations of the pin locator holes by first coloring the ends of the pins with a pencil, 8. Place the liftout gently into place, making sure it is aligned properly, with an equal gap at each end. Press the liftout firmly against the support 1 x 2s at each end, taking care not to alter the alignment, 9. The result will be four visible pin marks, 10.

Drill holes at the pin marks. These holes must be drilled perpendicular to

the resting surface, so use a drill press if possible, 11. Using a $\frac{1}{16}$ " bit (or to match your pins), drill the hole at least twice as deep as the pin.

Enlarge each hole at the entry with a T-handle reamer, 12. This makes the hole larger at the top, which allows the pins to slide in easily while still being held firmly. Use a spare pin to check the hole as you're reaming it. It should slip in easily, but the last $\frac{1}{8}$ " or so should be snug.

Press the support base 1 x 2s onto the pins and place the liftout in position. Use clamps to hold the 1 x 2 supports in place while you adjust their height and alignment, 13. Use a straightedge

to make sure that the top of the liftout is exactly the same level as the subroadbed. When both ends are aligned, use three 1½" No. 8 wood screws to hold each support in place.

When the liftout section is in place, you need to be sure that it stays firmly locked into alignment. To do this, I used a very low-tech but effective device, a 2½" hook and eye, 14. Screw the hook to the benchwork and locate the eye on the long 1 x 2 on the liftout. You want it loose enough that it's not difficult to hook but tight enough that it exerts a pull to keep the liftout firmly in position.

Lay the same type of roadbed across the liftout as on the layout and make sure the height matches. I prefer to use sectional track (instead of flex) at the joint, as the rigidity of sectional track helps keep things in solid alignment. Use track nails to secure the track, with a gap of ¼" between the rail ends on the liftout and layout, 15.

Electrical connections

This step is optional, but it will help limit the chances that you or one of your operators doesn't accidentally run a train over the edge if the liftout isn't in place. It's fairly easy to add a switch that kills the power to surrounding track sections when the liftout is removed. One way to do this is with a miniature single-pole, single-throw, normally open push-button switch, 16.

Route the track power to the adjoining track block through the switch. When the liftout is in place, the switch is pushed in, completing the circuit. As soon as the section is lifted out, the switch pops up, breaking the circuit and stopping any locomotives near the opening.

You also need to supply electricity to the liftout itself. You can use any two-connector plug connection, 17. Mount a cable with plug on the liftout and a jack on the layout. You can also use contact plates between the liftout and the layout to route electricity or use a couple of magnetic cabinet latches as described next.

Magnetic liftout

When Bill Darnaby needed a curved liftout section for his HO Maumee Route, 18, he decided to use magnetic cabinet latches to align the bridge, lock it in place, and conduct electricity, 19.



Two magnets hold the liftout on the bottom, while a third (at left) locks the side into position, keeping it aligned. *Bill Darnaby*



Gary Hoover built this simple swinging gate to provide easy movement through an access aisle on his HO layout. *Gary Hoover*

The technique would work well for a straight section as well.

These two photos tell the whole story. The liftout itself is a piece of ¾" plywood cut to fit (about 30" long). On each end, two magnets serve as the base with a third on edge to lock the side in place. Matching steel plates are secured to the liftout. Bill had to adjust the magnets a bit to eliminate any play or wobble in them.

Track power is fed through the magnets and picked up on the liftout by the steel plates.

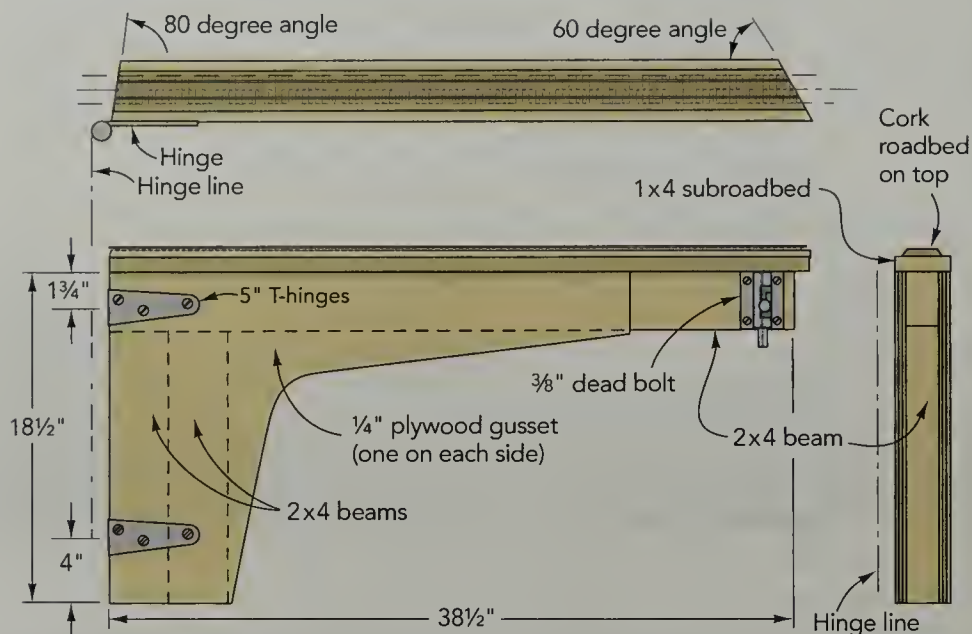
Bill installed and fit the liftout section, and then to ensure proper alignment, he laid the track directly across the bridge. He then used a motor tool with a cutoff wheel to cut gaps in the rails at each end.

Swinging gates

Another way to cross a gap is to hinge a section of the layout, allowing it to swing open to allow passage. The big advantage of a swinging gate over a liftout is that a gate stays secured to the layout: you don't have to find a place to set it when it's not connected.

The biggest disadvantages are the construction itself and potential alignment problems with the track and gate. Also, depending upon how it's installed, it can get in the way and be bumped while open. One of the best gate designs I've had the chance to use was on Gary Hoover's HO Missouri, Kansas & Quincy layout, 20. The key to the design is the angles on both the hinge and free end of the gate, which allow the gate rails to move cleanly away from the fixed rails on the layout, 21.

GATE CONSTRUCTION DETAILS



21

Clamp the 1 x 2 supports in place at each end of the benchwork. The ends have been rounded with a rasp and sanded.



22

Screw a steel shelf mounting peg into each corner of the liftout section.



23

Rail joints cut at an angle move cleanly as the gate is opened. Gary Hoover



24

Loops of flexible wire carry power between the layout and bridge at the hinge end.

The gate itself is an L-shaped 2 x 4 frame with plywood gussets on either side, held together with 1 1/2" No. 10 screws. The subroadbed is a 1 x 4, glued and screwed to the top 2 x 4. A 1 x 3 along each side of the subroadbed will catch trains in case of a derailment.

A pair of standard door hinges attach the gate to a 2 x 4 leg adjacent to the opening. The bottom of the leg on each side is glued to the floor with construction adhesive to keep them from moving.

The top 1 x 4 is cut to match the gap. As the figure shows, use an 80 degree angle on the hinge end and a 60 degree angle on the free end, 22. Install the gate and make sure the 1 x 4 is perfectly aligned with the subroadbed on each end.

Gary used a small nail and screw as stops for the closed gate. A vertically mounted dead bolt securely locks the gate in place. Make sure the striker plate of the dead bolt is adjusted, so there's no slack movement with the gate closed against the stops.

Gary laid the track directly across the

gate, using lots of spikes, and then cut gaps in the rails with a motor tool. Power is routed to the bridge with lengths of stranded flexible wire at the hinge end, 23.

A bit of expansion and contraction occurs from summer to winter, and Gary accounted for this with a removable track piece at the end of each track end at the free end of the bridge, 24. They are held in place with rail joiners. Gary uses two sections of slightly varying lengths and swaps them twice a year as the seasons change. You can do this with almost any liftout or gate design.



Benchwork as furniture

Making your layout room an attractive setting

We often view benchwork as utilitarian, and although we occasionally perk it up with under-layout shelves or painted fascia, few of us pay much attention to the room beyond the layout itself. You can turn your layout (and benchwork) into an inviting centerpiece for a rec room or other living area; it can be as simple as placing a layout on top of several attractive bookshelves. It can also be a more complex project such as integrating it with a museum-quality display.

Making your train room or layout area as attractive and welcoming as pos-

sible draws people to the space, perhaps inspiring you to spend more time there and working more on your model railroad. Steps you can take to improve a room include finishing walls, adding carpeting or other flooring, adding a finished ceiling, installing lighting, or decorating it with railroad-theme artwork.

This chapter highlights a few examples by modelers who have taken extra steps to make their benchwork more than just lumber that holds up a layout. I hope you're able to use some of their ideas on your own railroad.

Ken Lehman had limited space for a layout in his apartment, but he was able to fit this 8 x 12-foot L-shaped layout in a corner of his living room. By placing it atop commercial bookcases (these are from Ikea), the layout blends nicely into a living area.

Ken Lehman



Dick Patton has a very impressive On3 layout, but what makes his model railroad so striking is the way the layout is presented. The benchwork—and indeed, the whole basement—is designed as a small museum, with the layout just a small but integral part of the whole picture.

Dick collects all sorts of railroad memorabilia including headlights, station signs, lanterns, number boards, station furniture, and other items. Designing the whole basement around this theme makes it a very attractive area. As the photo shows, he has integrated a dispatcher's and agent's office into the scene. He has carried the typical old-fashioned wainscoting and woodwork around the basement and along the benchwork, which helps tie everything together.

All of the memorabilia and other items are attractively displayed, and although there's a lot of stuff there, it looks very neat. Most importantly, Dick's basement is a place that's inviting—it looks like it would be very enjoyable to spend time there, regardless of whether or not model trains are running. *Paul Dolkos photos*



Here, Rio Grande modeler and railroad artist Mike Danneman shows us another way to showcase a layout and memorabilia. The N scale layout is in a finished basement, and the broad curves of the fascia and backdrop give the layout a smooth, clean look. By displaying memorabilia neatly both above and below the layout, and keeping the layout area neat and bright, he has created a space that looks like a pleasant place to spend time. *Mike Danneman*



Lars-Göran Larsson provides another example of building a model railroad using bookshelves. A layout such as this would be attractive and yet unobtrusive in a living room, rec room, or bedroom. The HO layout is at eye level on a tall bookshelf with small fluorescent fixtures (mounted under the shelf above) for lighting. *Lars-Göran Larsson*



Bill and Mary Miller located a staging yard for their On3 layout in their family room, which is adjacent to the layout room. The railroad is an attractive addition to the room, which also serves as a crew lounge and waiting area on operating nights. The same idea can be used for a section of scenicked model railroad. *Bill Miller*

Enthusiasts For Life

ACHIEVE MAJOR IMPACT IN MINIMAL SPACE



Challenged for space? Shelf layouts need little benchwork and no floorspace. Explore the possibilities, practicalities, and challenges of linear layout design through prototype layouts. Complete construction details are included.

12419 • \$19.95



Acquire more space for scenery and longer mainline runs on your layout with multiple decks. Tony Koester walks you through design options, lighting and wiring considerations, and proven construction techniques.

12434 • \$19.95



This completely revised edition provides a variety of different HO, N, and O scale layouts encompassing portable, shelf, coffee table, and fold-up styles for modelers with limited room. Includes step-by-step instructions and a chapter on advanced techniques.

12442 • \$21.95



Buy now from hobby shops! To find a store near you, visit www.HobbyRetailer.com
www.KalmbachStore.com or call 1-800-533-6644

Monday – Friday, 8:30 a.m. – 4:30 p.m. CST. Outside the United States and Canada call 262-796-8776, ext. 661.

Build better benchwork

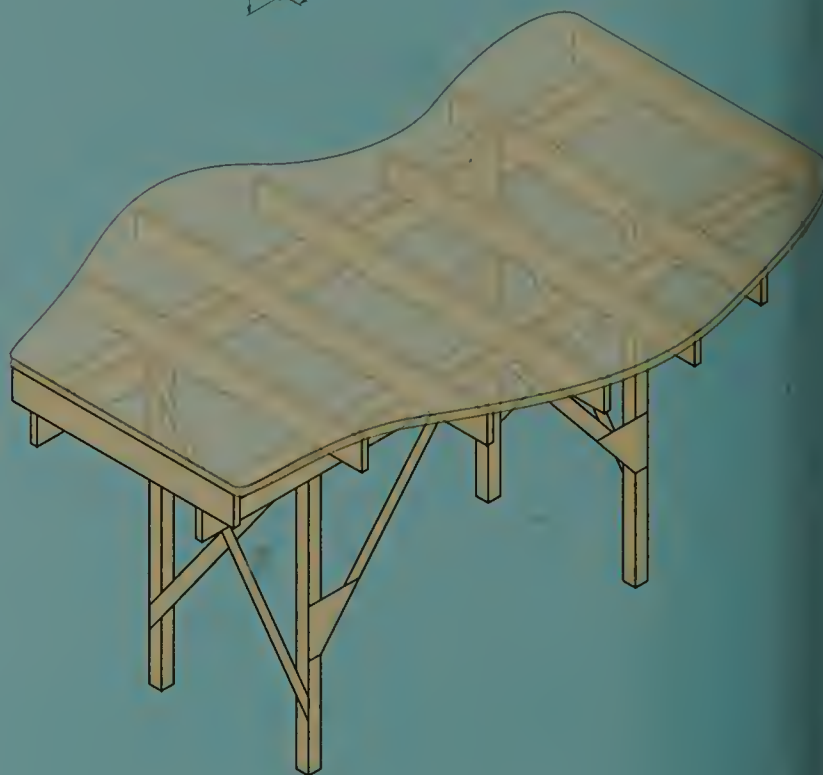
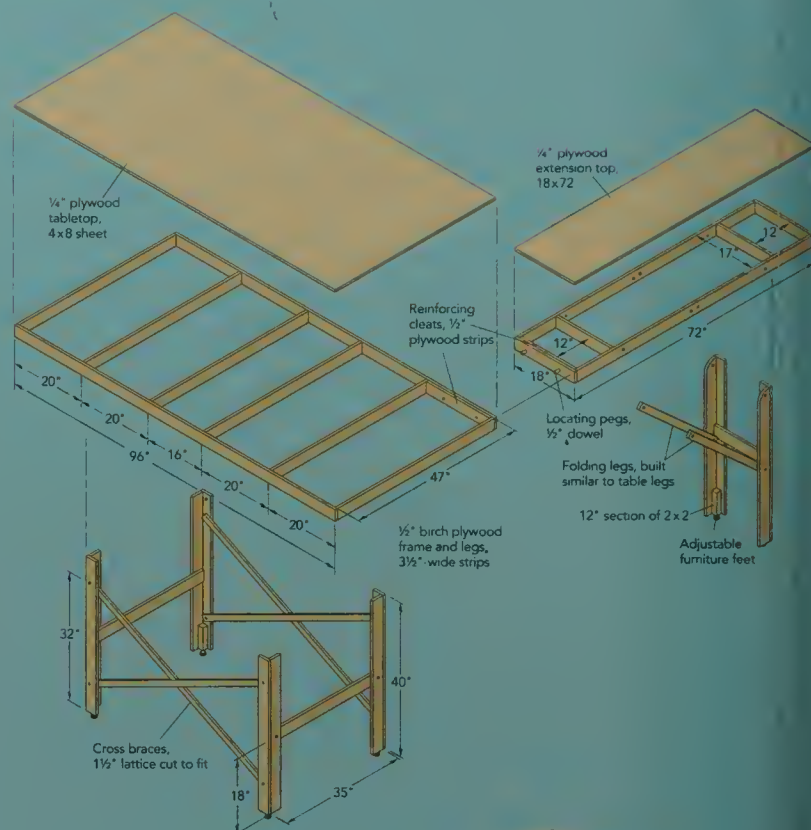
Benchwork serves as a solid base for your model railroad. Reliably operating your trains on smooth-running track depends upon having sturdy, level benchwork. *Basic Model Railroad Benchwork* shows you how, whether you plan on building your layout on simple tables or turning it into a piece of furniture.

This new edition of *Basic Model Railroad Benchwork* expands upon the original with additional ideas and techniques for these types of benchwork:

- L-girder
- Open-grid
- Steel-stud
- Around-the-walls
- Freestanding
- Multi-deck

You can get solid results even if you've never done any woodworking before. This book provides directions, photos, and drawings for building many styles of benchwork and other supporting components. You'll also be able to:

- Plan your benchwork
- Select lumber, foam, and other materials
- Extend your layout with backdrops and fascia
- Provide access with duckunders and liftout sections
- Add cookie-cutter or free-form roadbed
- Use foam as a benchwork material



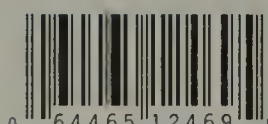
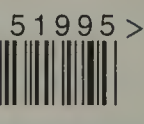
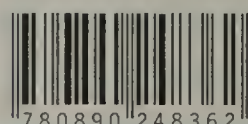
www.KalmbachBooks.com

\$19.95

U.S.

12469

ISBN 978-0-89024-836-2



9

780890 248362

0

64465 12469 5