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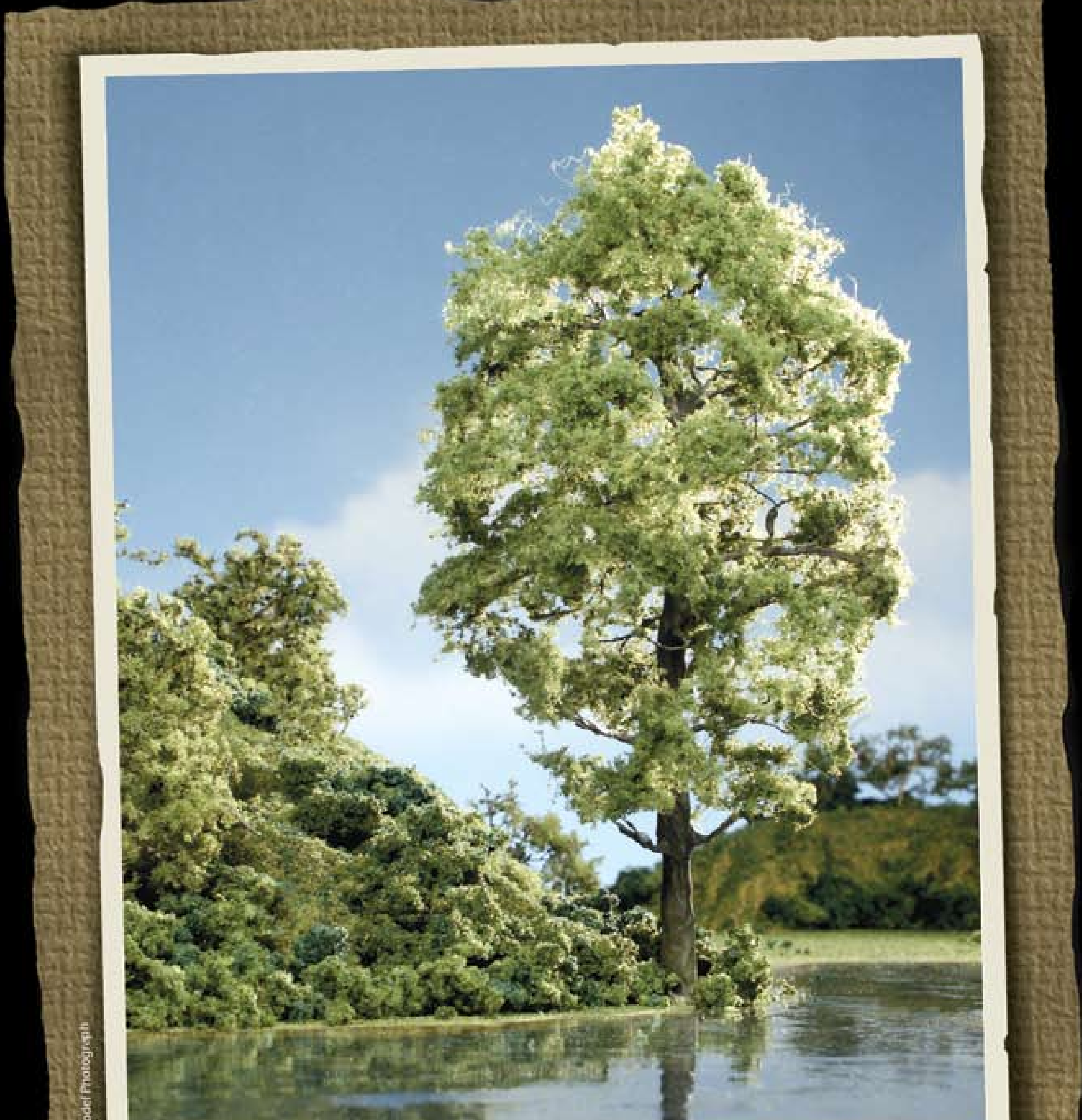

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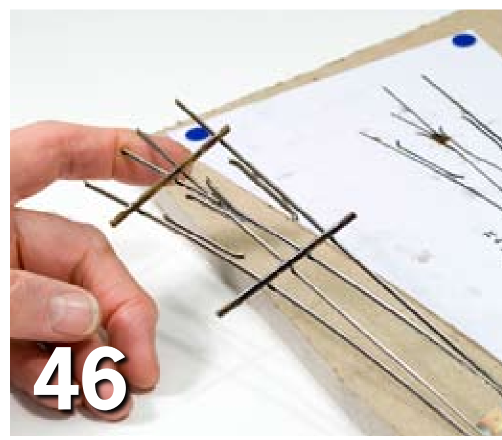
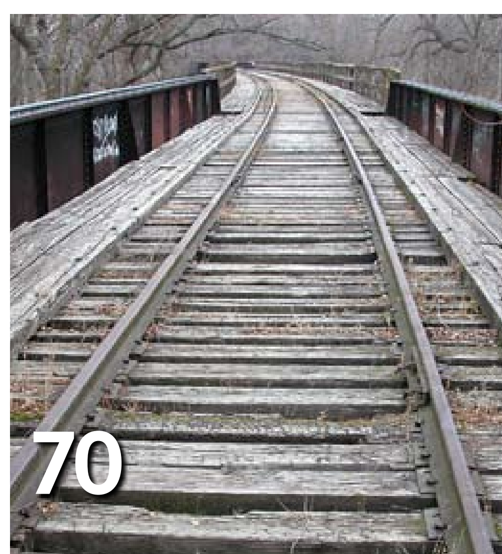
Model Railroader
SPECIAL ISSUE

How To Build Realistic Reliable Track

ON THE COVER: One of Lance Mindheim's superdetailed Micro Engineering HO turnouts shows how to treat track as a model just like engines or structures. Lance Mindheim photo





The track *is* the railroad

Few things are as essential to realism and reliability in a model railroad as the track. In any scale and for any type of rail system, track and its supporting right-of-way are the most basic elements of a railroad. This *Model Railroader* special issue is dedicated to helping you raise the standard of the track and track structure on your model railroad.

We have an all-star cast of talented model railroaders sharing their expertise. They do so in completely new and generously illustrated articles presenting both how-to-do-it and prototype background information.

Starting with our cover feature, Lance Mindheim will show you how to turn a top-quality commercial turnout into an eye-catching prototype model. That's complemented by Tony Koester's article on making the most of today's detailed flextrack. In another story Tony explains how to easily enjoy the benefits of custom trackwork by taking advantage of the latest materials, tools, and methods. And Paul Dolkos walks you through the sometimes daunting step of translating a track plan from paper to an actual layout.

You can see the results of careful attention to track and right-of way modeling in a photo tour of Mike Burgett's outstanding HO layout, and learn the techniques of modeling railroad civil engineering from Neal Schorr's scenic O scale hi-rail system. And our own David Popp shows how to apply the best model and prototype principals in building N scale trackwork.

The growing popularity of locomotive sound effects has brought the old question of how to achieve quiet roadbeds back to the forefront, and Bob Kingsnorth shares his experiments to discover what works and what doesn't.

These are just a few of the highlights awaiting you in this MR special. You'll find plenty of information you can use and inspiration to do so.

Andy Sperandeo

Free how-to videos online

See three of *Model Railroader's* own demonstrate track and wiring tips

Jim Hediger explains how to use the National Model Railroad Association standards gauge to check key trackwork and wheelset dimensions.

David Popp tells how he builds track to combine realistic appearance with reliable performance, and shares the latest views of his N scale Naugatuck Valley RR.

Andy Sperandeo, editor of *How to Build Realistic Reliable Track*, shares techniques he's learned for building reliablity into track wiring for Digital Command Control and sound as well as conventional DC.

Watch Jim, David, and Andy at ModelRailroader.com under Online Extras.

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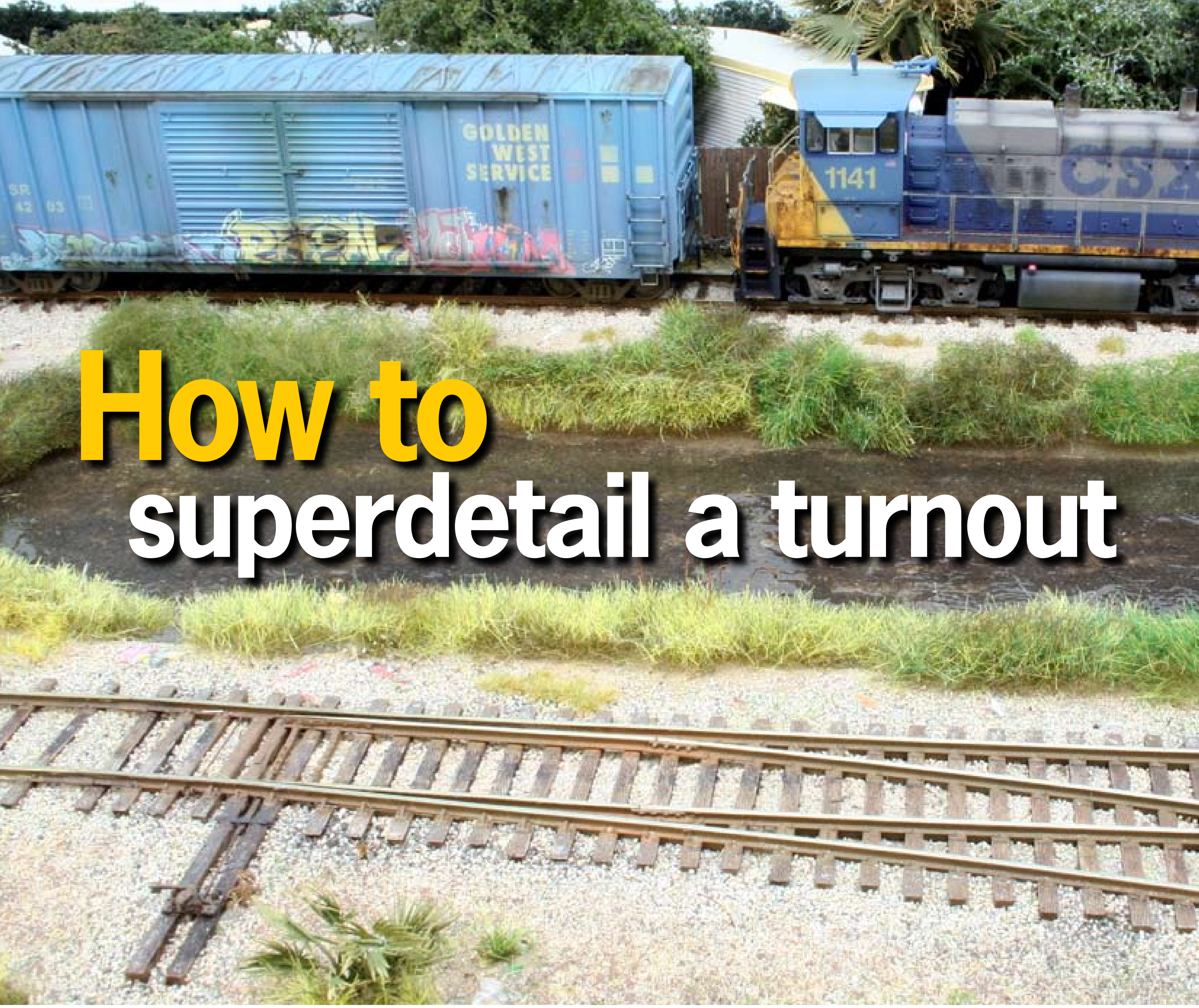


How to superdetail a turnout

Treat track as a model for close-up viewing or photography

By Lance Mindheim
Photos by the author

When it comes to detailing our models, trackwork often plays second fiddle to locomotives, freight cars, and structures. This doesn't need to be the case, as modeling track details can be simple and fun, and it can make a noticeable difference in close-up viewing and photos.

I once equated detailing track with handlaying. Now I realize that flextrack and ready-to-use turnouts are a better starting point simply because they come with tie plates and other details molded in, and may have closer-to-scale-size spikes.

I've also realized that detailing trackwork doesn't have to be an all-or-nothing proposition. If you have a favorite scene that you'd like to use for photographing your rolling stock, you can detail the track in just that area. Omit track details where they wouldn't be noticed.

Start with a turnout

Micro Engineering turnouts come with a lot of good detail molded in, including rail braces and appropriately sized turnout tie plates. They also come with a packet of separate details you can add. See the photo and list on page 9, which also show some after-market parts you can use for an even better detailed model.

Since Micro Engineering turnouts only come in no. 6, meaning a frog angle of one unit in six, this article is geared toward the smaller turnouts more likely to be found in yards and industrial settings.

In the prototype most turnouts are no smaller than a no. 8, even in yards. We need to be practical, though, in considering what's readily available as well as the space constraints of our layouts.

I'll cover three areas of upgrading the basic turnout. First there's the relatively simple task of adding bolt plates, reinforcing plates, and joint bars ("fishplates") to the turnout as a whole. For the more ambitious

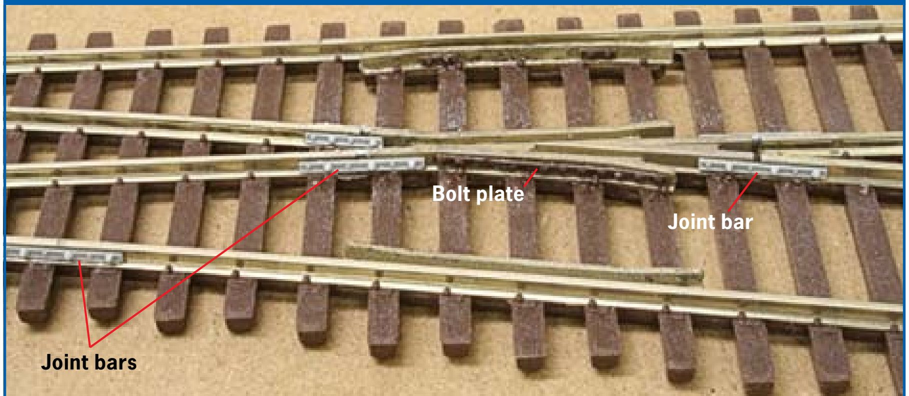
This superdetailed Micro Engineering turnout is up front on Lance Mindheim's HO layout. Lance explains how to treat a turnout like any other model subject to close inspection.

among you, I'll show you how to upgrade the switch rods. Finally, I'll explain how to paint the turnout so all the detail will stand out.

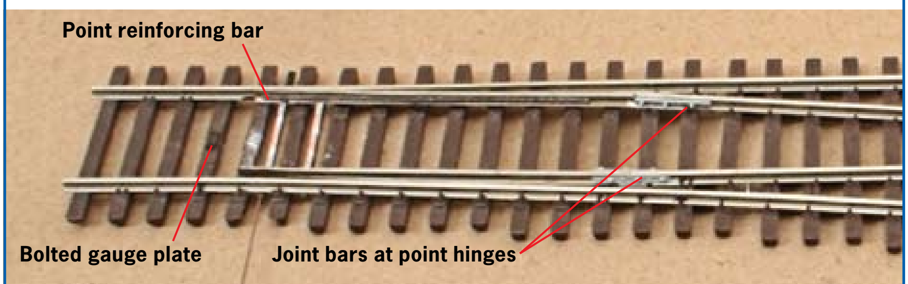
Keep in mind that in the prototype world there's a tremendous degree of variation in turnout details, even on adjacent turnouts in the same industrial park! Consider these techniques I'll describe as a general guide and food for thought.

Lance Mindheim, a frequent contributor to Model Railroader, *operates the Shelf Layouts Co., building and designing model railroads.*

Overall details



Frog details. You can see the rail joint and wing rail details Lance added. The joint bars are by Details West. Notice the file mark on the railhead at the joint bar at left. It simulates the joint between two rails.



Point details. The bolted reinforcing bars add interest to the switch points. The joint bars at the hinges must be placed to let the points move freely. (This photo also shows the closer-to-scale switch rods to be added later.)

Let's start with the additional parts supplied by Micro Engineering. The two long narrow brown bolt plates go within the web of the frog wing rails to make the frog look bolted together. Remove them from the sprue and clean up their edges. It helps if you bend them slightly to match the bends in the wing rails. Using a the tip of a push pin, flow some cyanoacrylate adhesive (CA) into the web of the wing rail and place the bolt plates on each side of the frog, as in **the top photo**.

The Micro Engineering parts vary a bit over time. On some kits you'll notice a gauge plate with three bolts. This goes on top of the first crosstie past the end of the points, as in **the lower photo**. Remove the entire part, and then using a hobby knife snip out the small plate under the three bolts and glue it in place.

There are dozens of parts in the Proto:87 Stores kit, but I don't use all of them for all projects. One especially handy part is the switch point reinforcing bar. It's a long plate that's bolted to the webs of the point rails for additional rigidity. There's one on each side of the fret.

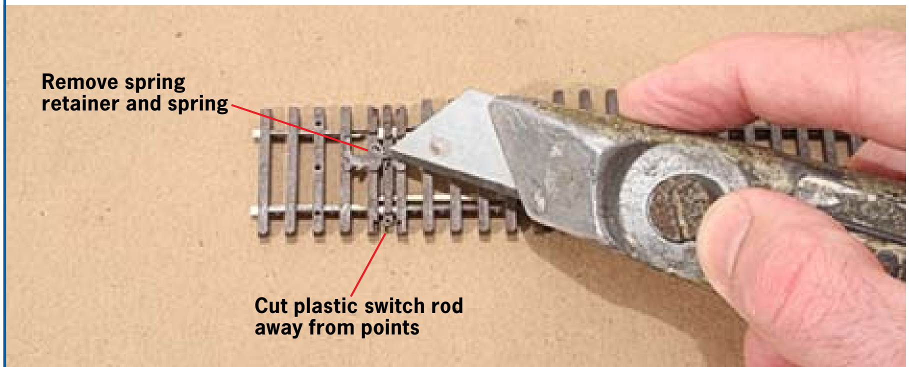
Using flush cutters, snip one reinforcing plate for each point. Place a light bead of CA along the web of the point rail and glue the bar in place as shown. The etching is thin and won't interfere with wheels. Save the other parts for turnouts with different details.

Finally, I add Details West joint bars. As the photos show, I put them in several places on the turnout, including about midway along each stock rail. Filing a slight notch in the railhead where you put joint bars can suggest the break between rail ends.

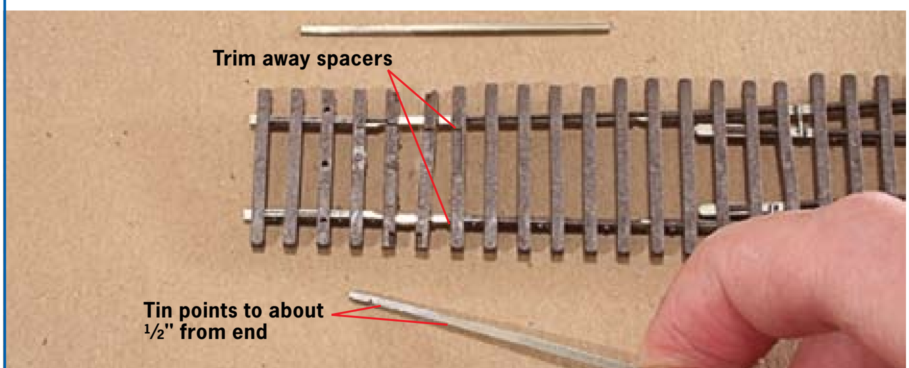
Micro Engineering electrically isolates the turnout frog with gaps on both sides. Span these gaps with more joint bars. I also add joint bars at the point hinges, gluing only one end of each bar so the points still swing freely. If in doubt, you might want to omit these.

These detail additions already dress up the turnout a lot, and you may wish to jump ahead to the section on painting. To take the detailing a step further, the next section deals with upgrading the area around the points.

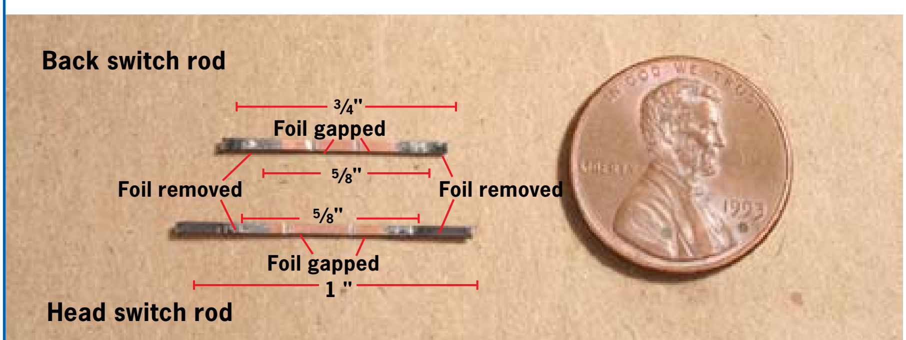
Switch rods



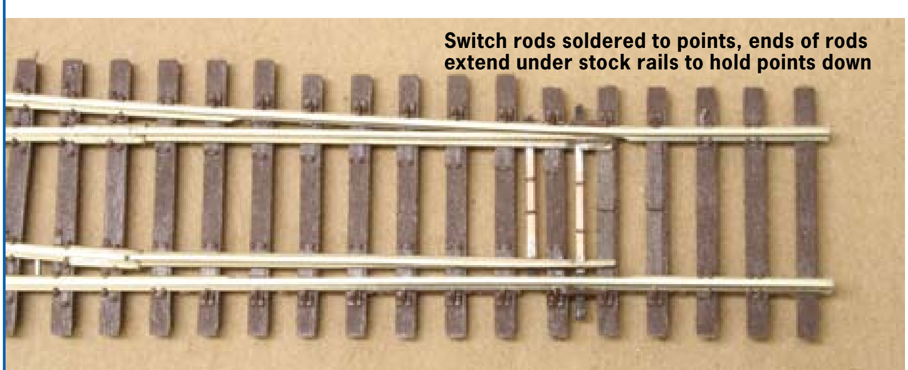
Switch rod removal. **The turnout's toggle spring and plastic switch rod have to go to make way for new, smaller, switch rods.**



Preparations. **Lance tins the bottom of the points and cuts away the tie spacers as shown to prepare for the installation of the new switch rods.**



Switch rods. **First Lance filed N scale printed-circuit-board tie stock to a width of 3⁄64" to 1⁄16". Then he cut it to length and gapped it as you see here.**



Points with switch rods. **Lance uses shims to hold the switch rods tightly against the underside of the points while soldering them in place.**

For years I operated under the premise that all turnouts should be operated by slow-motion switch motors. While it's nice to be able to flip a toggle and set the switch points electrically, I've begun to view this as unnecessary mechanical overkill for those turnouts located close to an operating aisle and handling lighter traffic. In many cases, simply moving the points with your fingertip works fine, and it's easy to introduce enough light friction to hold the points in position.

Prototype turnouts have a great deal of detail around the points. Not having to allow for beefy switch rods (the railroad term for what modelers usually call "throw bars") to handle the often excessive force exerted by switch-motor actuator wires allows opportunities for finer detail in this part of the turnout.

The first step is to replace the turnout's overly wide plastic switch rod with a more realistic, thinner part. Begin by turning the turnout upside down as in **the top photo** and gently prying off the spring retainer; remove the spring as well. Use a knife or a flush-cutting rail nipper to snip away the plastic switch rod.

With the switch rod gone, the points will be relatively loose and can be removed from their rail joiner hinges as in **the second photo**. File off any burrs you find on the bottom of the points, then lightly tin the bottom of each point from the tip to about ½" back.

("Tin" means to coat with solder. Let the solder flow from the tip of a hot soldering iron held against the bottom of the point. Applying a tiny amount of liquid rosin flux to the bottom of the point will help.)

Turnouts always have a "head" switch rod at the headblocks, the long switch ties that support the switch stand or motor, and depending on the prototype and the length of the points, may have a one or more "back" switch rods for additional rigidity. A single back switch rod is usually one tie closer toward the frog from the head switch rod.

When you look at the bottom of the turnout, you'll see that Micro Engineering molds spacers between each tie. You'll need to cut away the tie spacers where the back switch rod will go, as shown in the second photo.

Make the new switch rods from Clover House N scale printed-circuit-board (PCB) tie stock. (Proto:87 Stores produces scale switch rod castings, but I haven't tried them yet.)

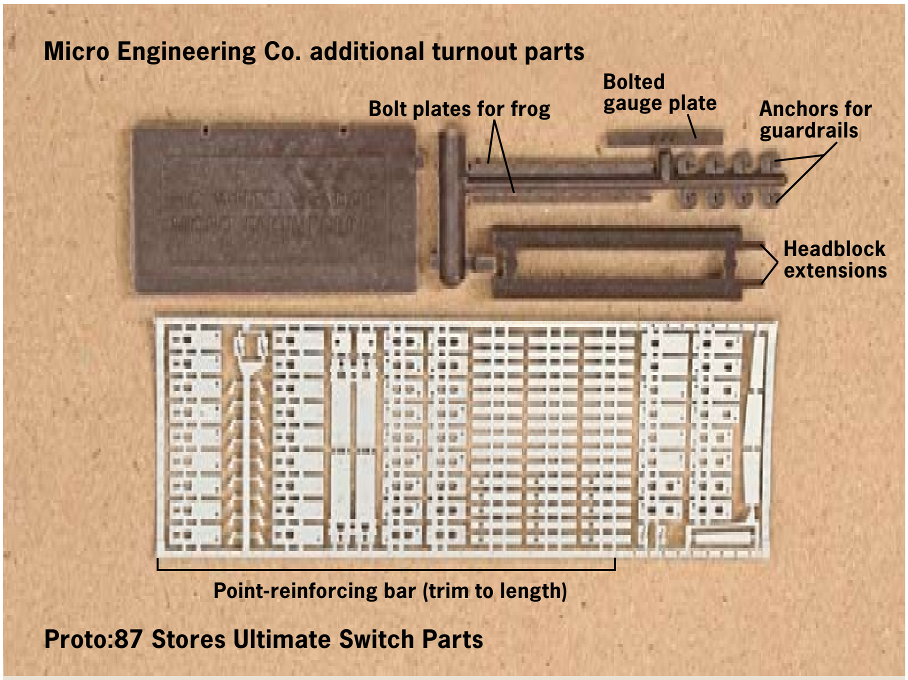
First thin the PCB tie stock to a width of 3⁄64" to 1⁄16" using a small file. It's easiest to file a several-inch long piece of PCB stock before cutting it to length, so you'll have more of a handle to grip. The material is soft and the filing goes quickly.

Once you've thinned the PCB tie to width, cut the head rod and back rod as in **the third photo**. Shave off the foil on each end of the rods, leaving 5⁄8" remaining in the center. Gap the foil with one or two file cuts across the rod so the points will still be insulated from each other after you solder them to the switch rods.

Tin the PCB switch rods and solder the points to them as in **the bottom photo**. Since the PCB material isn't as thick as the plastic turnout ties, it helps to put a temporary shim under the rod to hold it tightly against both points while you solder them.

The spacing between the open point and the stock rail in the original turnout is wider than scale to conform to the National Model Railroad Association standard for electrical clearance. In soldering the new switch rods you have the opportunity to make the turnout look a litle more realistic by leaving a narrower gap between the open point and the adjacent stock rail. Since the point will have the same electrical polarity as the stock rail, it won't matter if a metal wheel touches both at the same time.

However, it's easy to get carried away and make this gap too narrow. Test the point-to-stock rail gap with a truck that you commonly use. If you find the wheels hitting the open point you'll have to widen the gap somewhat. Finally, fill in the insulating gaps you filed in the PCB ties with plastic putty so they won't be obvious in the finished turnout.



Here's a closeup view of some of the track detail parts Lance used in superdetailing the Micro Engineering HO turnout.

Materials list

Micro Engineering
14-805 code 70 left-hand no. 6 turnout (14-806 right-hand)
80320 parts kit for code 70 turnout (included with above)

Clover House (www.cloverhouse.com)
260 N scale modern 9"-wide printed-circuit-board ties

Details West
916 ground throw (dummy)
933 joint bars

Floquil paint
110007 Rail Brown
110073 Rust

Model Master paint
2038 Light Gray (FS 36492)

Proto:87 Stores (www.proto87.com)
TPSW3 Ultimate Switch Parts

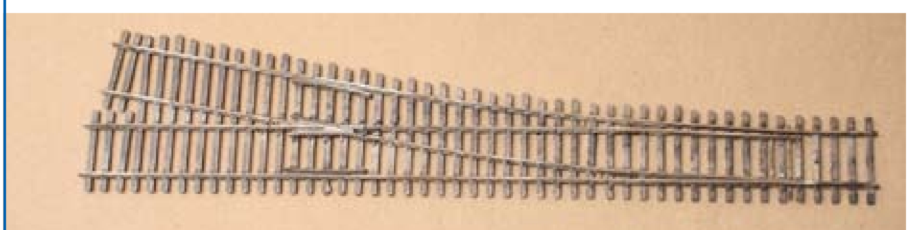
Tichy Train Group
1106 .0125" phosphor-bronze wire

Miscellaneous
Burnt umber artist's oil paint

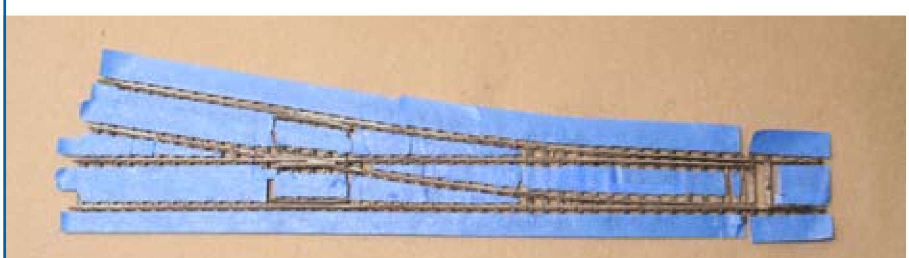
In this closeup of a prototype turnout, you can see the the point-reinforcing bar bolted to the web of the switch point rail near the top of the photo. For more detail photos of full-size turnouts, see page 11.

Painting and weathering

Base coat and wash. **After airbrushing the turnout with Model Master Light Gray enamel, Lance sets up as shown to apply a wash of burnt umber artist's oil paint. (A "wash" is mostly thinner with just a little color.)**



Wash applied. **Here's the turnout after the oil paint wash. The uneven, somewhat mottled finish is intentional and realistic.**



Masking ties. **Lance masks the simulated wood surfaces of the ties to spray all parts that represent steel in one operation.**

Painting complete. **The Rail Brown and Rust airbrushing makes the metal details of the turnout stand out from the wood finish of the ties.**

Our eyes are extremely sensitive to color, so painting the turnout realistically helps to improve its appearance just as much as the additional details. While much prototype rail is of a dark color, I've learned the hard way that lighter rail shades make the difference between seeing all of your detail work or losing it in the shadows.

Begin with the ties. I prefer a very light, neutral gray as the base coat, one that doesn't have a strong brown or blue tint. Model Master Light Gray is a good choice. Using an airbrush, spray the entire turnout as shown in **the top photo** and let it dry for a day or two.

[We recommend that you clean the railheads before letting each coat of paint dry, because it will be considerably more difficult to remove the paint after it cures. Lance explains how he does this in the next to last paragraph of this section. – *Ed.*]

Don't forget to also paint the headblock extensions, which Micro Engineering includes as separate parts with the additional details. They're separate so you can install them on either side of the turnout as your layout situation requires.

Next add a creosote tone by applying a dilute wash of burnt umber artist's oil color. In the top photo you can see how I place a small blob of oil paint on a scrap of plastic that I use as a palette. Next to it I put a capful of ordinary hardware-store paint remover for oil-based paints.

Dip a soft watercolor brush in the paint remover, then lightly tap it in the umber paint, remembering that a wash has more thinner than paint. Lightly flow this coffee-color wash over the ties, making sure to cover the sides and ends of each tie. When everything is covered your turnout should look like the one in **the second photo** on the opposite page. Artist's oils take a while to dry, so let the turnout sit for several days.

Now comes the most time-consuming part of the project, masking the simulated wood surfaces of the ties. In the end your efforts will be rewarded, as there's a tremendous amount of detail cast into the ties that for the most part goes unnoticed. Painting will bring these details out. The idea is to mask the wood parts so you can spray paint all of the turnout parts that are steel in the prototype at one time. These parts include the rails, switch rods, and tie plates.

Carefully mask the wooden areas of the ties, leaving the steel parts exposed, as shown in **the third photo** on the opposite page.

If you want to keep paint off the mating surfaces of the point and stock rail, you can slip a wooden tie into that gap. However, since the point is ordinarily powered through the hinge, whether it makes electrical contact with the stock rail or not doesn't really matter. See "Final tuning" on page 13 for how to handle a switch point that isn't getting power through the hinge.

Once all the masking is in place, airbrush the turnout with Floquil Rail Brown. Follow up with a very light overall airbrush dusting of Floquil Rust. Finally, apply a few more quick puffs of Rust to highlight the more detailed parts, like the joint bars, frog, and points. See **the bottom photo** on the opposite page.

Before the paint has a chance to set, clean it off the railheads by soaking a block of soft wood in paint thinner and gently wiping it back and forth along the rails.

After the paint dries, carefully loosen up any stiffness in the points by gently working them back and forth. If they seem overly stiff, scrape away some of the paint around the points with knife blade.

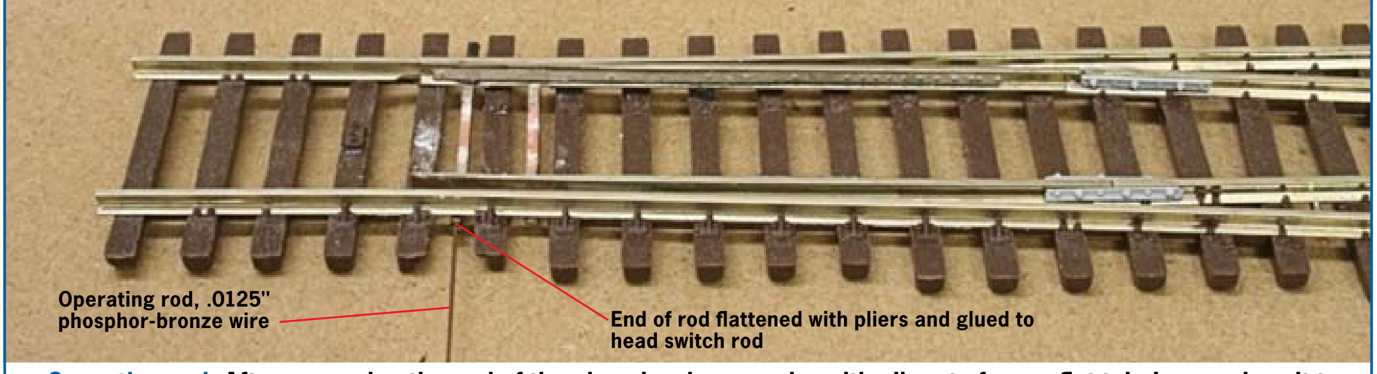
Here's the kind bolt detail along the frog wing rails that can be modeled with the add-on parts included with the Micro-Engineering turnout. To the right of the frog are the joint bars connecting the frog to the closure rails.

The headblocks, the extended ties at the point end of the turnout, serve as a rigid mounting for the switch stand. Other details here include four rail anchors along the stock rail to the right, and a switch point protector or guard. This raised, outside guard rail deflects wheel flanges away from the tip of the point to reduce point wear and prevent flanges from picking the point.

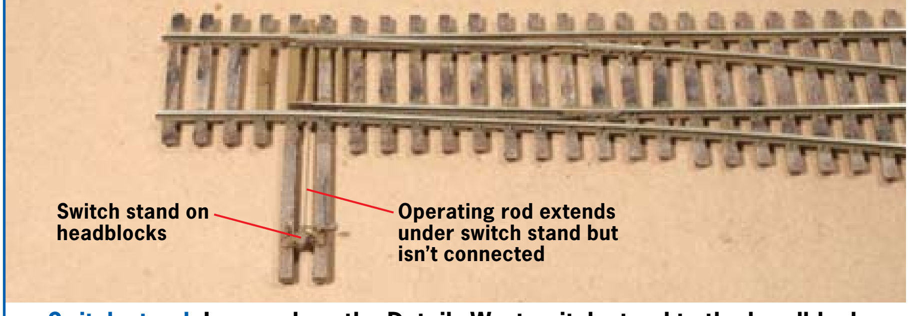
The moving parts of the turnout, the points, are called the switch. Here you can see the two switch rods that connect the points so they move as a unit. The left point of this switch is spiked and the switch stand has been removed, so the diverging leg of this turnout is apparently out of service.

Ballast and final details

Ballast. **Lance uses a minimum amount of ballast under the points, to avoid interfering with the movement of the switch. You can see that the ballast is mostly below the height of the ties.**



Operating rod. **After squeezing the end of the phosphor-bronze wire with pliers to form a flat tab, Lance glues it to the end of the head switch rod with a drop of CA. For clarity, the head block extensions aren't shown here.**



Switch stand. **Lance glues the Details West switch stand to the headblocks with CA. The rod merely extends under the non-operating switch stand.**

After installing the turnout on your layout, with the headblock extensions, it's time to add ballast. Work gingerly around the points and use very little ballast. I generally bring the ballast up to only half the height of the ties under the points, as you can see in **the top photo**.

To secure the ballast I use a mixture of 1 part white glue, 3 parts water, and a splash of alcohol as a wetting agent. There's no need to flood the ballast with the glue mix because as long as it can work its way through the rock it will do the job. A minimum of adhesive will be less likely to gum up the switch, the moving parts of the turnout.

Last to be added are the connecting rod and switch stand. For clarity the photos showing this were taken with an unballasted turnout.

Fashion the operating rod from a 1" length of .0125" phosphor-bronze wire. Squeeze the end of the wire with pliers to form a small tab, then glue the tab to the head switch rod as in **the middle photo**, using a drop of CA. Paint the rod Rail Brown.

The switch stand in **the third photo** is Details West's no. 916 ground throw. It's a lot like those I've seen in yards and industrial parks. Paint it Rail Brown too and weather it lightly with dark brown and black powdered pastels. The connecting rod extends under the switch stand, but they aren't really connected.

Final tuning

Final tune-up. **Lance checks the movement of the points, adds a shim for friction if necessary, and also checks the electrical continuity. Then the detailed turnout not only looks realistic, it works reliably too.**

After the ballast dries, gently work the points back and forth until they move freely. If a point won't fit tightly against the stock rail, the likely culprit is an errant piece of ballast. It only takes one grain to foul up the works! Use a magnifier to look into the gap between the points and stock rails and remove any stray pieces of ballast with a hobby knife.

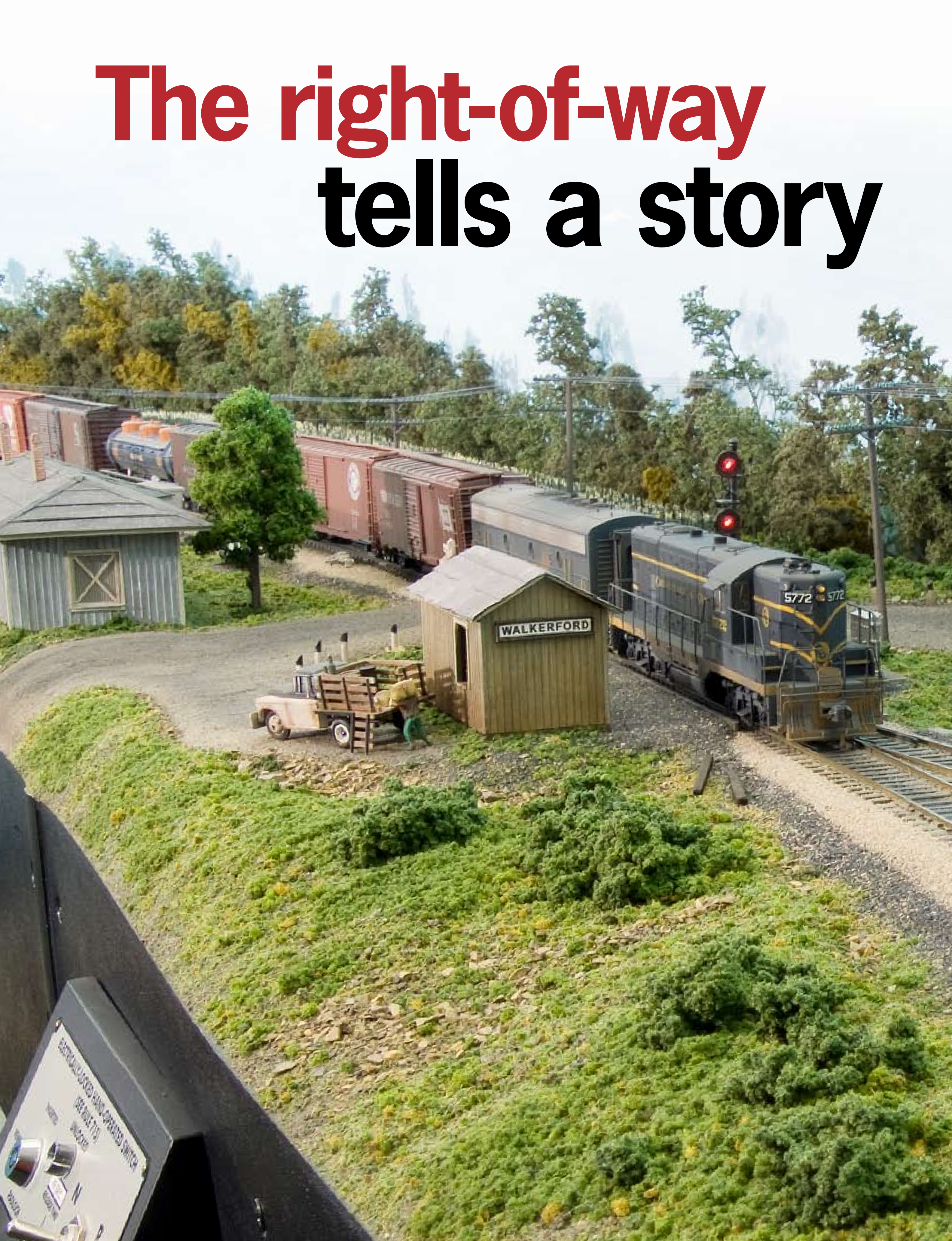
If the points are too loose, you can add some friction by sliding a shim of .005" styrene under one of the point rails. That's usually enough to hold them in place.

The points rely on the rail joiner hinge for electrical power. On occasion, this connection will be compromised by all of the handling and painting the turnout has been through. I test the points by turning the track power on and checking for current with a small bulb.

If a point isn't receiving current through the hinge, I solder a tiny jumper of flexible wire to an inconspicuous spot near the hinge and connect it to the main power bus. A small wire soldered low on the rail and then painted will hardly be noticeable. For a final check, run a locomotive through the turnout as in **the photo above**, testing both routes.

That's how to make a turnout stand up to the same kind of scrutiny as your best locomotive, car, or structure model. RRT

The right-of-way tells a story



Track and engineering details can help define the character of a model railroad

By Michael J. Burgett
Photos by Andy Sperandeo

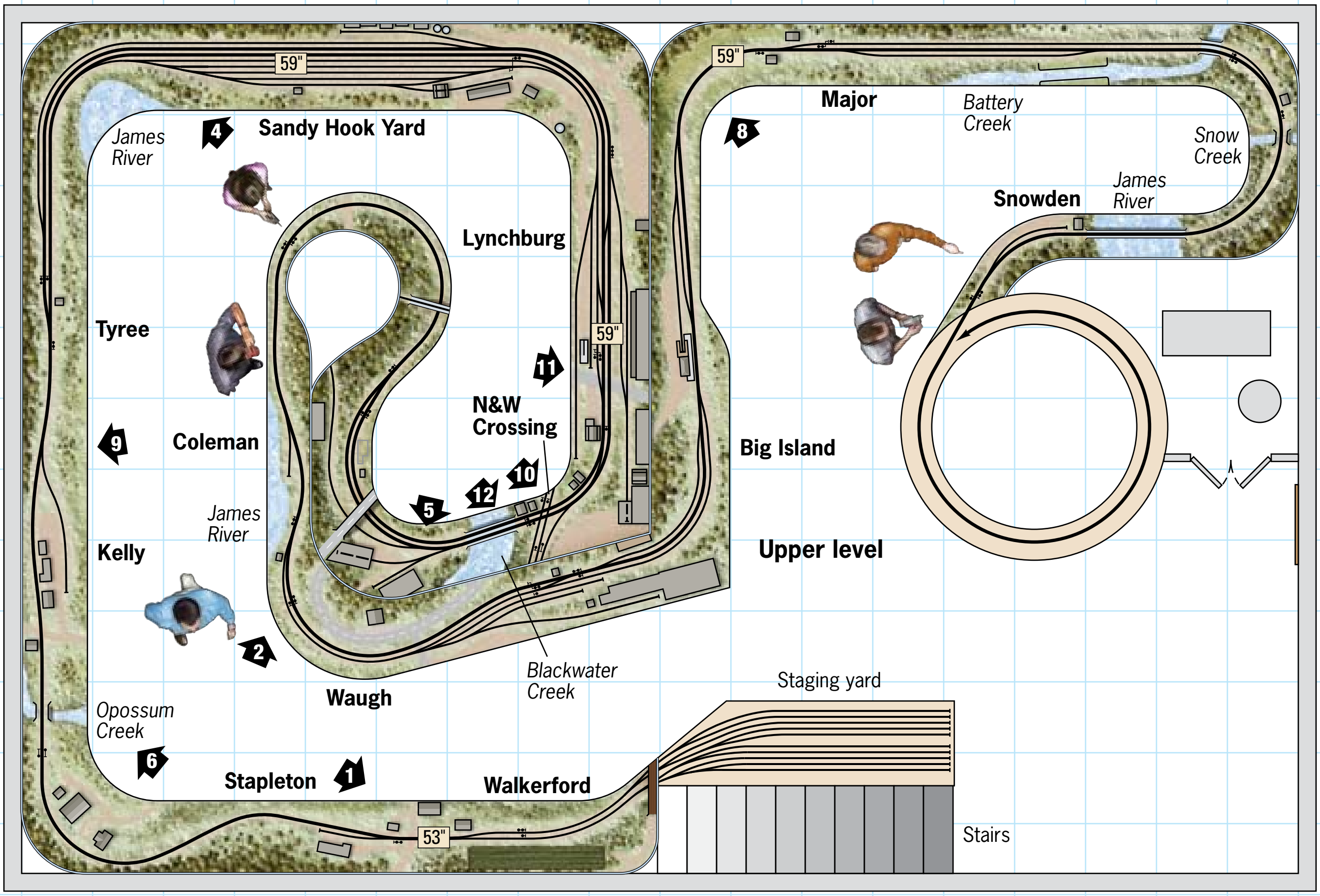
A railroad's track and right-of-way can tell a story of the track's use and the railroad that owns it. Track and right-of-way can reveal everything from the density of traffic that traverses a given line to the overall financial stability and philosophy of the carrier.

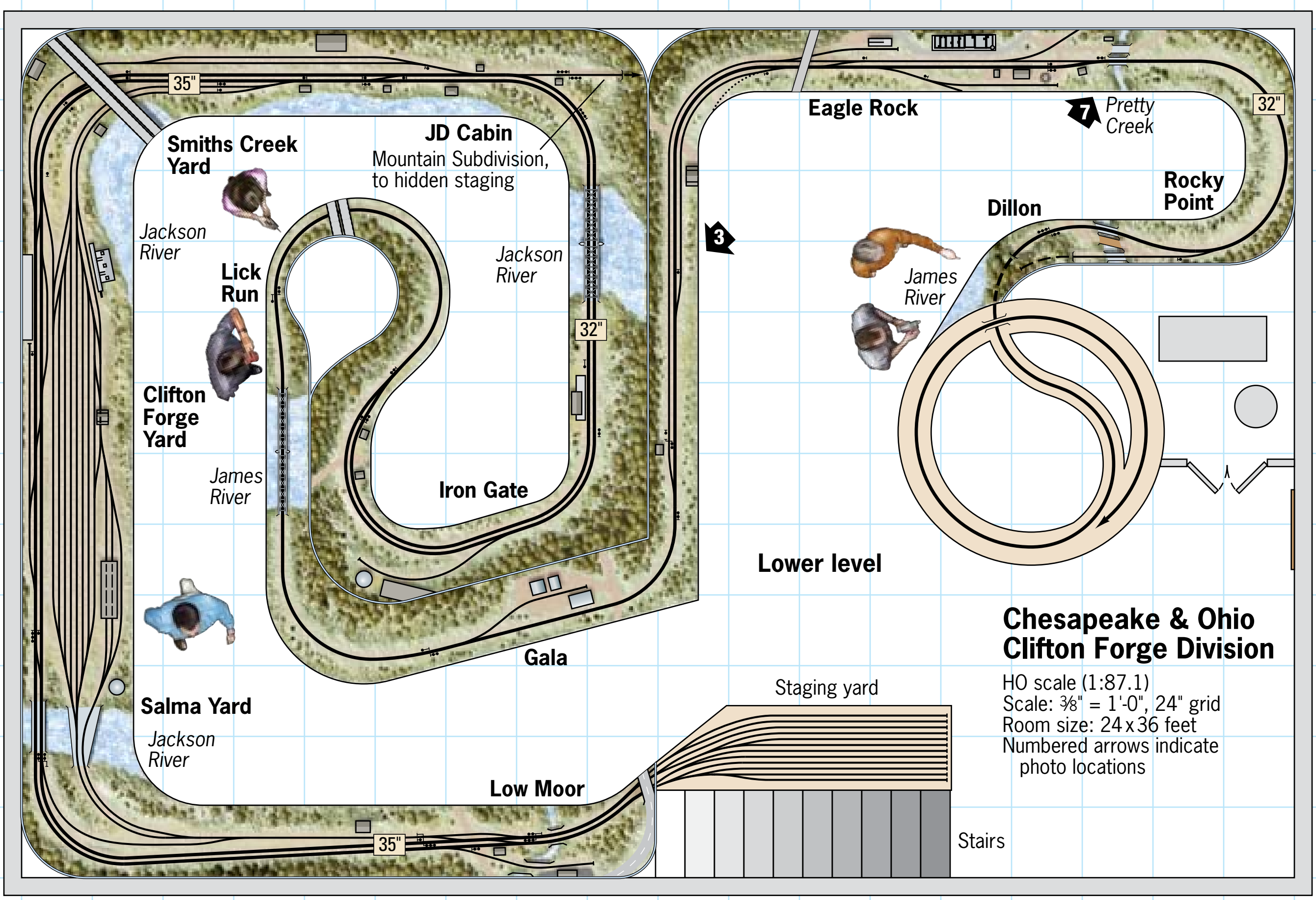
Having spent my railroad career in the engineering department, I find modeling the right-of-way a fascinating subject in itself. Everything from the type of ballast to the construction of retaining walls tells a story of that particular company.

To show how this perspective plays out on a model railroad, I'm inviting you to take a photo tour of my HO scale Chesapeake & Ohio layout. It represents the James River Subdivision of the C&O's Clifton Forge Division in central Virginia, and is set in August 1965. You probably model a different prototype, or maybe a free-lanced line, but I hope you'll see how the details of track and right-of-way can help tell the story of your railroad too.

Mike Burgett is a signal supervisor for the Canadian National Ry. in Detroit, Mich. He also offers parts and services for modeling prototype signal systems under the name Control Train Components (www.ctcparts.com). This is his fifth publication in Model Railroader *special issues and* Great Model Railroads.

1. Well-maintained mainline ballast on a defined cinder subgrade characterizes Mike Burgett's HO Chesapeake & Ohio layout. The C&O was flush with coal revenue in the mid-1960s, and Mike models a railroad re-investing in its track and right-of-way.





Chesapeake & Ohio Clifton Forge Division

HO scale (1:87.1)
Scale: ⅜" = 1'-0", 24" grid
Room size: 24 x 36 feet
Numbered arrows indicate photo locations

Illustration by Rick Johnson

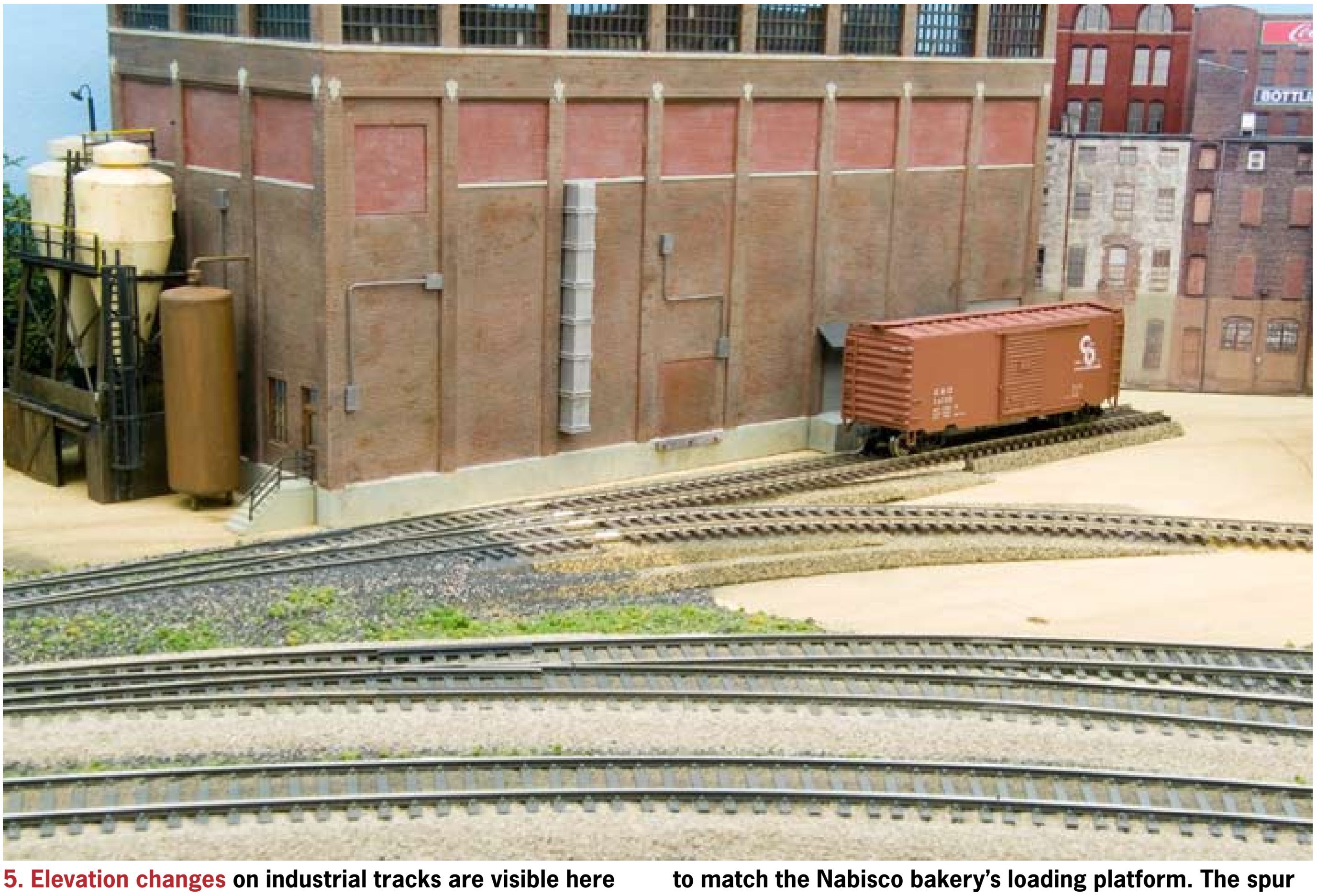
2. The difference in elevation between the main line on its bed of light-colored ballast and the siding laid directly on the cinder subgrade is easy to see at the east end of the siding at Big Island, Va. Mike has continued the cinders down the side of the right-of-way to represent an embankment filled in above the James River.

3. The roadbed transition here at the west end of Eagle Rock, Va., shows how Mike builds elevation differences into his right-of-way. Still under construction, this area reveals that the mainline track is on two layers of cork roadbed, and that cork sanded into a gradual ramp leads from the turnout down to the siding on subgrade level.

The layout at a glance

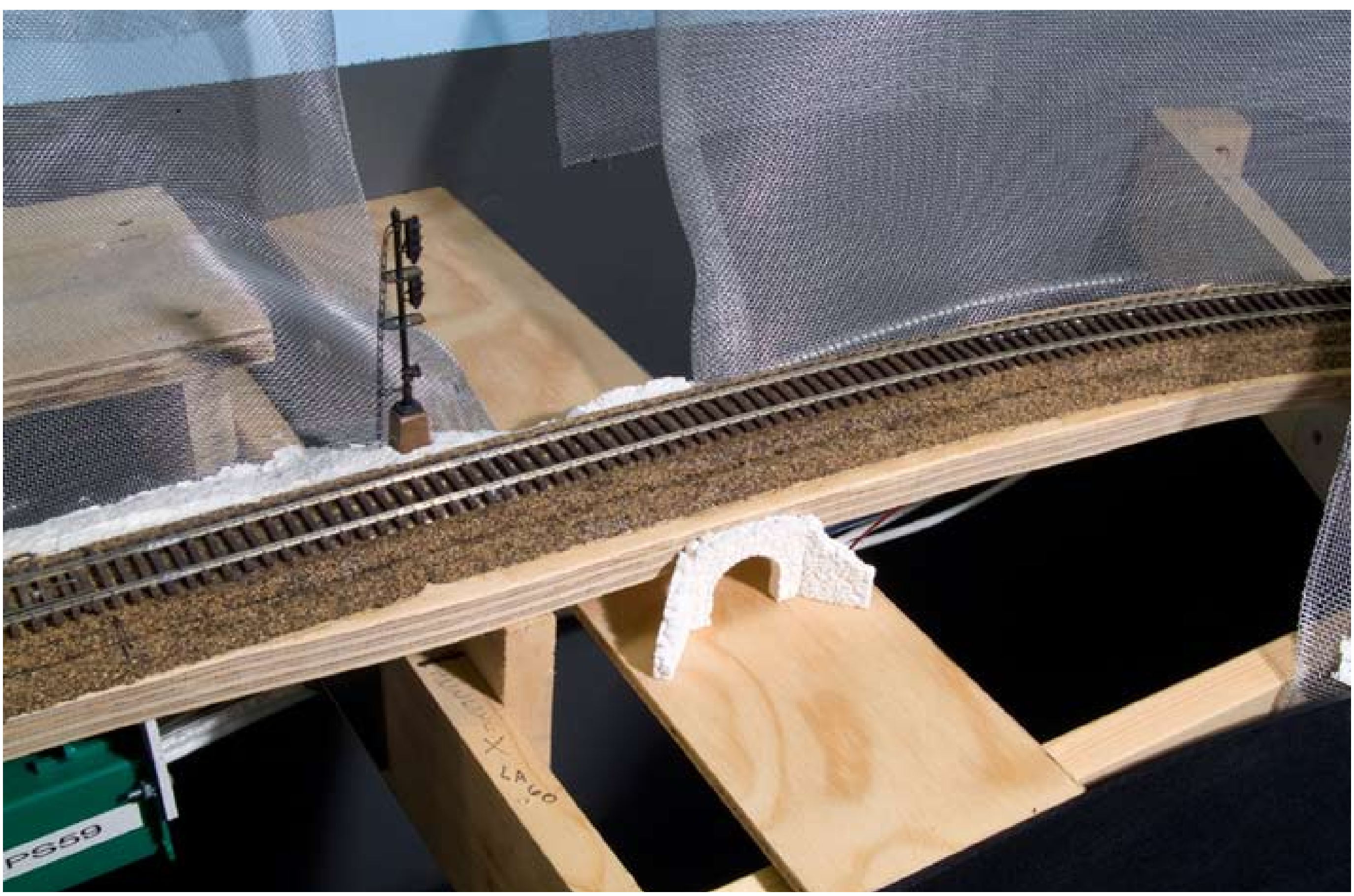
Name: Chesapeake & Ohio
Scale: HO (1:87.1)
Size: 24 x 36 feet
Prototype: James River Subdivision of the C&O's Clifton Forge Division
Locale: central Virginia
Period: August 1965
Style: double-deck walk-around
Mainline run: 600 feet
Minimum radius: 28"
Minimum turnout: no. 6
Maximum grade: 1.8 percent
Benchwork: open grid
Height: lower level 36", upper level 59"
Roadbed: cork on ¾" plywood
Track: Atlas code 83 and Micro Engineering code 70 flextrack
Scenery: Hydrocal over screen wire
Backdrop: drywall and ⅛" Masonite
Control: CVP Products Easy DCC Digital Command Control

4. The higher profile and limestone ballast of the two main tracks are apparent here at the east end of Lynchburg, Va's., Sandy Hook Yard. They contrast with the lower cinder ballast of the yard tracks. For years the C&O built and maintained its lines using tons of cinders from its coal-burning steam locomotives, a much cheaper material than crushed stone. Mike uses a combination of Scenic Express Fine Cinder and Highball Z Scale Cinder ballasts.



5. Elevation changes on industrial tracks are visible here where Mike is still working to complete this part of industrial Lynchburg. The spur where the boxcar is spotted remains at subgrade height – one layer of cork roadbed – to match the Nabisco bakery's loading platform. The spur extending to the right comes all the way down to ground (plywood) level on a ramp of sanded cork roadbed on its way to a factory yard off to the right.

6. A stone culvert carries the C&O over Opossum Creek near Kelly, Va. The track is on a fill above the creek's flood plain, but a fill is a potential dam unless there are outlets for both regular and intermittent watercourses. Even large earthworks will be washed away unless the right-of-way is engineered for adequate drainage. Mike likes to quote the railroad executive who said the three most important things in railroading are drainage, drainage, and drainage.



7. A culvert under construction at the future site of Pretty Creek, east of Eagle Rock, shows how Mike places cast plaster culvert and wing walls. He'll incorporate the culvert into the contours of the railroad embankment using aluminum screen wire and Hydrocal. You can also see Mike's typical method of modeling the C&O's heavy-duty mainline profile, with a top layer of cork ballast strip over the wider cork subgrade. The flextrack is glued in place.

8. A deep fill **supports the big curve between Major and Big Island, The roadbed extends beyond the slope of the hillside on a relatively deep earthwork. This kind of engineering shows the railroad is willing to spend money to maintain an even grade. Mike's use of cinders on the embankment helps to highlight what he's modeled.**

9. The berm **supporting the headblocks (the long switch ties) for the wood yard switch at Kelly is wider than the top of the subgrade, so the small timber retaining wall allows the earthwork to be built out over the slope of the embankment. Equipment across the track includes the relay case for the electric switch lock, and a telephone box – black and white, on the stub pole – so train crews can call the dispatcher for permission to unlock the switch.**

10. A railroad crossing at grade presents an opportunity to model some identifying features of the other company. Signalman Mike has installed the Norfolk & Western's characteristic color-position-light signals to protect the diamonds that carry the N&W across the C&O in Lynchburg.

Photographic concrete

12. The stained concrete of the abutment and pier at the Blackwater Creek bridge looks realistic because it's a photograph of real concrete.

Concrete structures can be hard to model because of the challenge of representing their staining and weathering realistically. For the supports of the bridge over Blackwater Creek in Lynchburg, I adapted a photographic technique my friends Daniel Cyrus and Chris Wiley and I have used for background structures in the same city. We shot a digital photograph of a suitable concrete wall, squared it up and adjusted if for size on a computer, then printed it and laminated it to abutments and a pier I built from styrene. We described the method in more detail in "Make your town look bigger with digital buildings," in *How To Build Realistic Layouts 4, Trackside Town and City Scenery. – M.J.B.*

11. The highway crossing at grade must be the most familiar railroad engineering feature to the largest number of Americans. Here at Washington Street in Lynchburg, the C&O protects its busy double-track main and the lead to Sandy Hook Yard with automatic flashers and gates. Mike's crossing signals are triggered by track circuits, of course, and he modeled the asphalt roadway and crossing with the Woodland Scenics "Smooth-It" road building system. RRT

The quality of sound available from today's decoder-equipped locomotives can be masked by noise from the track. Bob Kingsnorth tested many combinations of roadbed materials to find out which would best minimize this background noise.

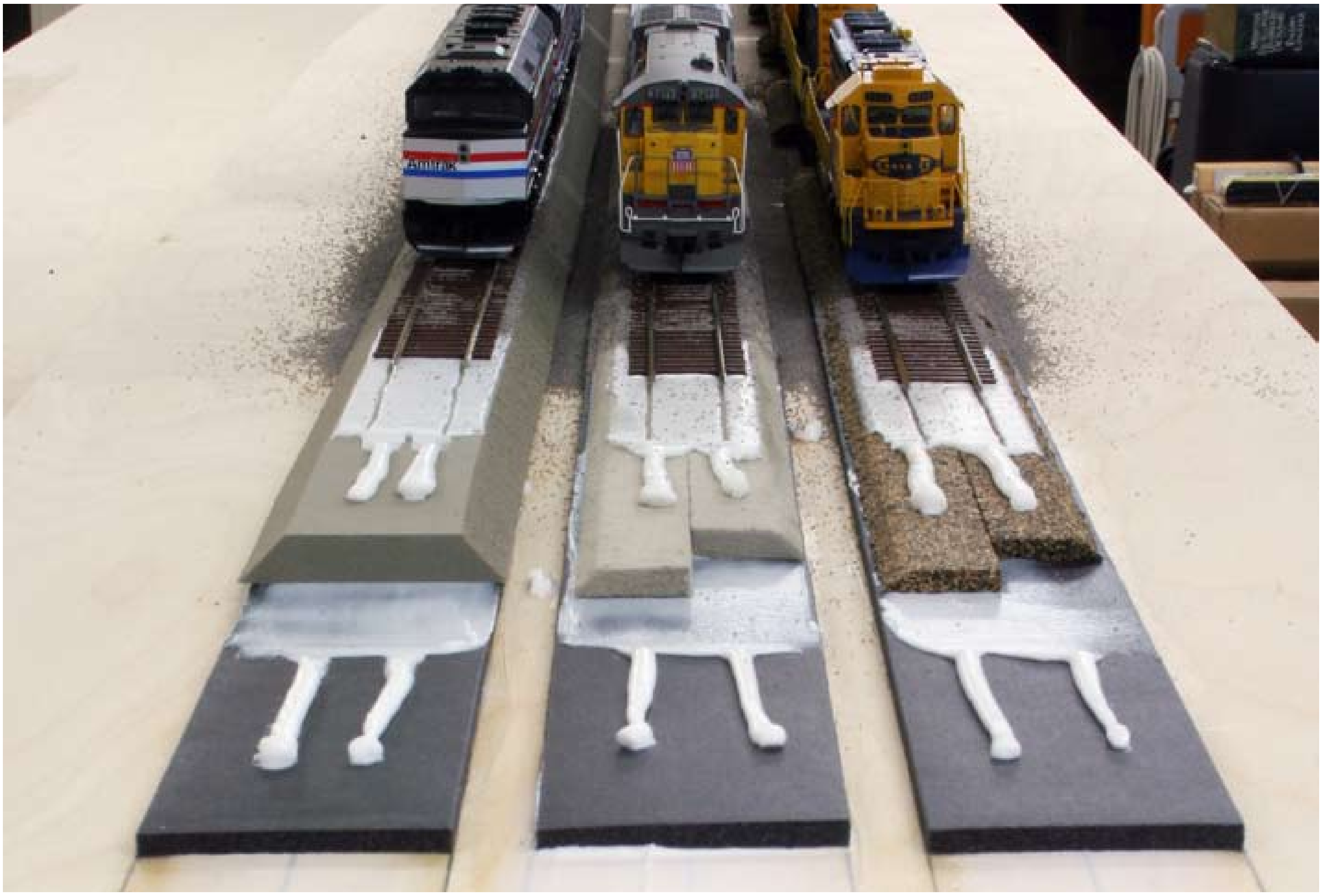
Quiet roadbed, better train sounds

Noise-damping roadbed lets locomotive sound systems sing

By Bob Kingsnorth
Photos by the author

What roadbed system best showcases today's onboard sound systems? How do you deaden the model noise to allow the sound system to be appreciated? To answer those questions and to decide how to build a layout that provides the best platform for onboard sound, I conducted a series of experiments. My methodology was very subjective – I listened.

Perception of sound is difficult to quantify. When we hear a broad spectrum of noise ("white noise") from our trains, each of us is more sensitive to different frequencies. Each of us has memories of the sound of a locomotive or a passing train, and expectations of specific sounds, volume, and pitch. Background noises and acoustics will also affect our



Bob's tests found that the quietest roadbed was a two-layer combination of, from left to right, Flexxbed, Homabed, or cork glued onto a base of foam camper tape. The chart on page 25 compares different combainations of materials.

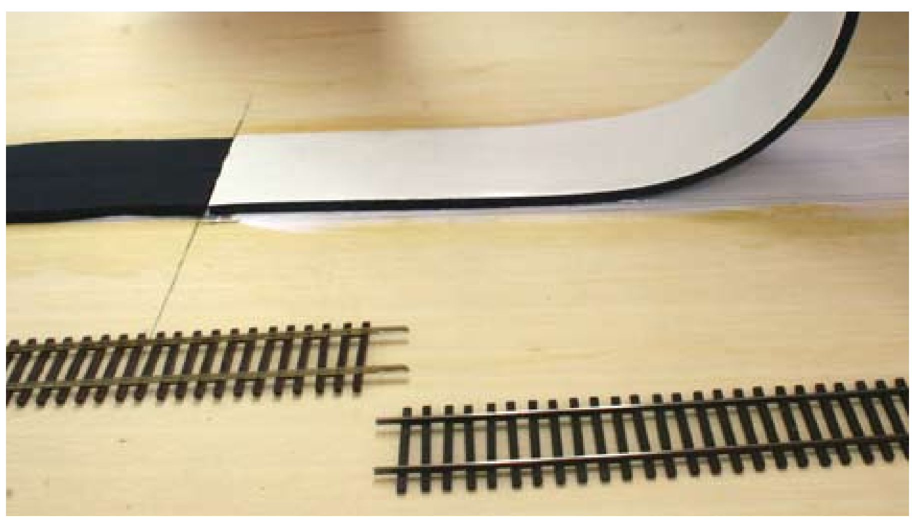
perceptions – room shape and materials, the din of a club room, or the solitude of our home layout.

I tested many different HO roadbed combinations, detailed in the table on page 25. Though I often had difficulty describing what I heard from the models, I had no difficulty in recognizing the quietest combinations. Along the way, I observed several factors that I hope will help you find the best option for your layout.

The gold standard

How quiet is "quiet?" Try this. Spread a bath towel on a stable surface in your train room and lay a piece of flextrack on it. Gently push a freight car back and forth on the track, allowing the car to glide from end to end. Now do the same test on your layout.

The near silent rolling of the car on the bath towel is my gold standard. The towel effectively suspends the track in midair and minimizes vibrating surfaces. But once that track is attached – or even simply laid – on a firm surface, we start to get amplification of model noises.



The stiff, white paper backing of the camper tape makes laying straight sections of roadbed very easy. Then remove the paper so the next layer of roadbed can be glued directly to the tape.

None of the combinations of roadbed materials I tested eliminated all the noise. Even the best are a far cry from my gold standard, but I found some combinations of materials that are far better than traditional construction methods.

The test track

I built a 5 x 15-foot oval with 32" radius curves and full easements, using HO code 70 flextrack on a ½" plywood tabletop. The track oval was divided into four quadrants, each with a different roadbed combination.

The camper tape's paper backing must be removed to allow it to be bent around curves. Bob cuts the tape into two narrow strips to make it easier to flex without kinks. He glues it to the plywood subroadbed with latex adhesive caulk.

Each quadrant provided a nine-foot run of track. This setup allowed me to compare different combinations side by side, with continuous running.

I swapped out the roadbed in each quadrant, testing 18 basic configurations, plus varieties of adhesives and ballasting techniques. I found that compared to the choice of roadbed material, ballast had little effect on rolling stock noise.

For my tests I used a quiet diesel locomotive and four of my quietest freight cars. I also pushed cars by hand, and ran the locomotive alone. Finally, I ran a train pulled by a sound-equipped locomotive to evaluate the effect on the audibility of built-in sound. I evaluated the characteristics when running at a scale 35 mph and 70 mph.

Two kinds of noise

I focused on two sources of noise that modelers try to control and reduce. The first is the active noise and vibration of the motor, flywheels, drive shafts, gears, and wheels of the locomotive. The second is the sound of the rolling stock's wheels on the rails.

The vibrations of a locomotive's drive train can be strong enough to be transmitted though the roadbed to the subroadbed below. The plywood (or other material) becomes a soundboard that amplifies these vibrations. Some of these sounds are relatively low-pitched; to some extent, they can be masked by the lower tones of our sound system and may even enhance the rumble we desire. A soft roadbed provides good damping of these unwanted vibrations.

The higher-pitched vibration of the rolling wheels can be transmitted between the wheels, rails, and carbody. This noise tends to conflict with and distract from our onboard sound systems. Although the sound from one car is relatively minor, the noise from a string of them adds up, and it can be more significant than the sound of the locomotive. Though this matches the effect you hear when standing alongside a track on the prototype, the high-pitched noise made by our model cars sounds little like the real thing, so it's best to reduce it as much as possible. HO rolling stock is generally lightweight, so little of this sound is transmitted through the roadbed, and the top layer of roadbed is usually sufficient to control it.

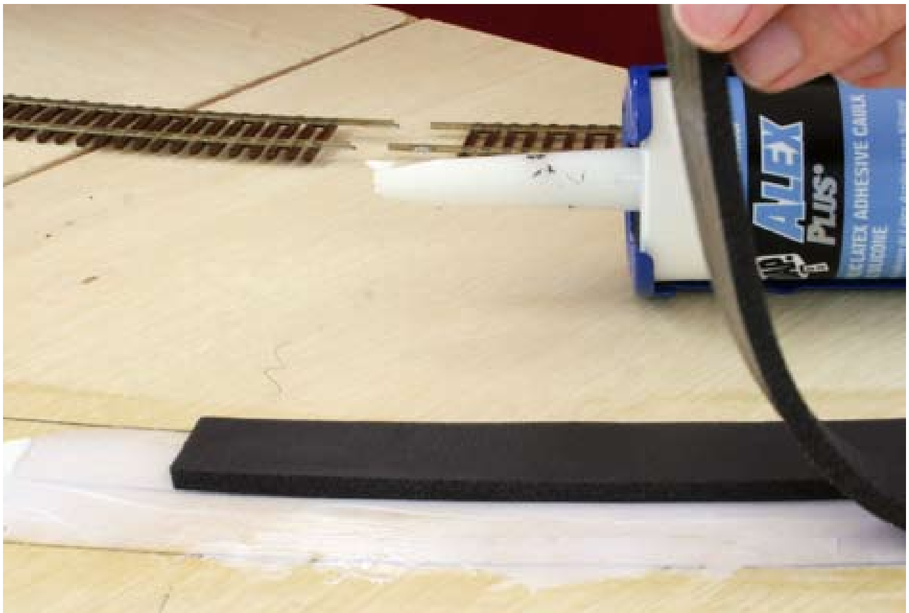
The volume of each sound is important, but I found that pitch can be more significant. The higher-pitched noises seem the most unrealistic and thus the most objectionable to me, though I also want to minimize the heavier vibrations of locomotives.

The speed of a train has a direct effect on the volume and balance of its sounds. The faster a motor turns, the more noise it makes. Noise is a minor issue on a slow-speed switching layout

Sound Evaluation of Roadbed Configurations

Configuration		Overall effectiveness (1 is best)	High pitched noise (wheel-to-rail)	Low-pitched noises (locomotive)	Comments:
Cork Camper tape Sub-roadbed (plywood)	Cork on camper tape	1	1	2	Very good control of noises. Thick caulk provides a further, but small, improvement in high-pitched noises.
HomaBed Camper tape	Homabed on camper tape	1	1	2	Very good control of noises. Thick caulk provides a further, but small, improvement in high-pitched noises.
Flexxbed Camper tape	Flexxbed on camper tape	1	1	2	Not as quiet as other top performing combinations, but lower pitch. Ballast slightly increases high-pitched noise.
Cork Foam rubber	Cork on 3⁄8" foam rubber mat	2	1	1	Very good noise control. Very thick and soft roadbed. Availability of foam rubber mat may be a problem.
Homasote Camper tape	Homasote on camper tape	2	1	3	Produces higher-pitched noise than others, but at a lower volume. Low-pitch damping is not as good.
Camper tape	Camper tape	2	2	1	Material by itself is soft, but acceptable. Good damping of low-pitch noise, but high-pitch noise is noticeable.
Micore or Homasote	"Floating" track on Micore or Homasote	3	2	3	Loosely attached track with minimum spikes or nails. Noise damping qualities are lost when ballast is glued.
Micore Camper tape	Micore on camper tape	3	2	3	Results similar to Homasote/camper tape, but high-pitched noises more noticeable.
3M camper tape	3M camper tape	4	3	2	Top surface is a tough plastic film that must be removed if the tape is to be formed around curves.
Ace super firm sponge tape	ACE Hardware super firm sponge tape #57632	4	4	3	Available in one size - 3⁄16" x 1¼".
Cork Track-Bed	Cork on Track-Bed	4	4	4	The cork seems to reduce high pitch noises and the Track-Bed reduces low pitch vibrations.
Flexxbed	Flexxbed	4	4	4	Provides some damping of high and low pitched noises.
Track-Bed Camper tape	Track-Bed on camper tape	4	5	2	Moderate damping of low pitched noise. Seems to emphasize high pitched noise.
Cork Micore	Cork on Micore	4	4	5	A reasonable blend of high and low pitch noises, but somewhat louder than other combinations.
Track-Bed	Track-Bed	4	6	3	Good damping of low pitched noise. Seems to emphasize high pitched noise.
Cork	Cork	5	6	6	Traditional configuration.
Micore	Micore	5	6	6	Traditional configuration.
Homasote	Homasote	5	7	6	Traditional configuration.

Note: I established the overall effectiveness by ranking the sum of the low-pitch damping plus double the high-pitch damping plus any demerits for concerns of availability or awkward installation. I found the high-pitch noise to be more intrusive, therefore gave it a double weight.



Though the tape has its own adhesive, Bob uses clear latex caulk to allow him to adjust and reposition it. Without the paper backing, the tape is easily stretched or compressed, so a light touch is needed.

To split camper tape, Bob pushes the tip of a hobby knife into the plywood and pulls the tape past the knife.

Hush those cars

When you're running trains on a very quiet roadbed system, you will notice a wide variation in sound generated by different types of wheels. I have found that machined metal wheels are quieter than cast metal wheels. (You might be able to spot cast wheels by foundry data on the face, a parting line on the back of the wheel, and/or brackets on the back.) Generally, a cast wheel is microscopically rougher than a machined wheel.

Plated wheels may be shiny, but they're not necessarily smoother. Plating deposits more metal on the high points and less in the crevices, making the surface microscopically rougher.

I've stayed away from plastic wheels because they collect and distribute gunk attracted by static electricity. The uneven treads of dirty wheels will add to the noise.

Polishing metal wheel treads with ultra-fine emery cloth or a fabric wheel may help reduce noise. Any polishing must be parallel with the wheel tread, not across the tread.

A final warning: I've found wide variations even from the same manufacturer with the same cast or machined wheel treads, so you may end up sorting through your inventory to find the quietest wheels.

The bodies and components of locomotives and rolling stock can cause or amplify unwanted sounds. These sounds are transmitted directly through the air to your ear. You may have heard a buzz from a locomotive (perhaps a loose wire vibrating against the plastic shell), or the "tin can" sound from a boxcar (perhaps caused by the vibration of a thin sidewall). These sounds can be heard no matter what roadbed combination you use. I'm still experimenting with hard and soft bracing and reinforcements to minimize these vibrations. I've had some success adding extra bracing and gluing automotive sound deadening material inside the shell. – *B.K.*

when compared to a 70 scale mph train. Putting all these components together and adding an onboard sound system creates many variables, and there will be trade-offs to achieve your sound expectations.

The quest

In my search for a good sound deadening roadbed system, I was inspired by Flemming Örneholm's multi-component construction mentioned in his article "Wide open spaces in a small room" (*Model Railroader,* October 2006). The closest that I could come to Flemming's configuration was cork roadbed on top of a 3⁄8" foam rubber exercise mat. Although its sound-damping qualities were excellent, I had concerns about the thickness and softness of this combination. I also wondered whether other modelers would be able to find the same foam mat year after year.

My next inspiration was Chuck Hitchcock's camper tape, described in his article "Quick and easy flextrack" (MR, August 2003). Chuck used a foam tape used to seal caps and camper shells on pickup trucks. I tested several configurations using foam camper tape. The most effective used the tape as a base under a layer of cork, HomaBed, or Flexxbed (made by Hobby Innovations, flexxbed.com).

In the best combinations, each of the two layers serves a purpose. The dense top layer does the best job of deadening the wheel-on-rail noises. Pushing a set of freight cars on the track by hand produces a soft, low-pitched white noise. A bottom layer of foam camper tape does the best job of isolating the heavier vertical vibrations of the locomotive and isolating any vibrations of the top layer. With the two-layer camper tape combinations, I couldn't just hear the difference, but also feel the difference when touching the plywood tabletop. The combined effect was impressive and works well to enhance my sound-equipped locomotives.

The tackiness of the caulk is sufficient to hold cork, Homabed, or Flexxbed on a curve, except at the ends. Even at a fairly gentle 32" radius, a couple nails or pins are needed to hold the roadbed in place until the caulk dries.

Addressing the drawbacks

There are trade-offs with these combinations of materials. First, the give of the camper tape makes the roadbed relatively soft. In my tests, a 20-ounce locomotive causes code 70 track to sink 0.001" as it passes. The camper tape that I used allowed a 0.003" flex when used alone. This flexing seems relatively minor, but the pressure applied when cleaning track with an abrasive block will cause noticeable flexing. This could over time cause rail joints to work loose, so I recommend soldering them.

Another drawback is that the cork and Flexxbed top layers won't hold spikes for hand-laid track. On any of these roadbed combinations, spikes may work their way out over time due to the flexing of the roadbed. Nails or spikes long enough to be anchored in the plywood subroadbed will transmit unwanted vibrations directly to it, negating the benefits of using the camper tape roadbed in the first place. Therefore, I recommend using a flexible latex adhesive caulk to hold the track and roadbed instead of spikes. As Chuck Hitchcock described in his article, the high tack and good working time of this caulk makes tracklaying very simple.

Sound and scale

My tests were done in HO scale. Based on my observations, I suspect that the results will be applicable to the smaller N and Z scales. The larger mass of S or O scale equipment may be too much for the soft foam camper tape. You might start with this particular foam tape, and if the weight is too much, try a stiffer foam. That option may diminish the damping characteristics, but the greater mass of the large scales will create more desirable low frequencies to begin with, and you will have the benefits of larger speakers and more powerful sound systems.

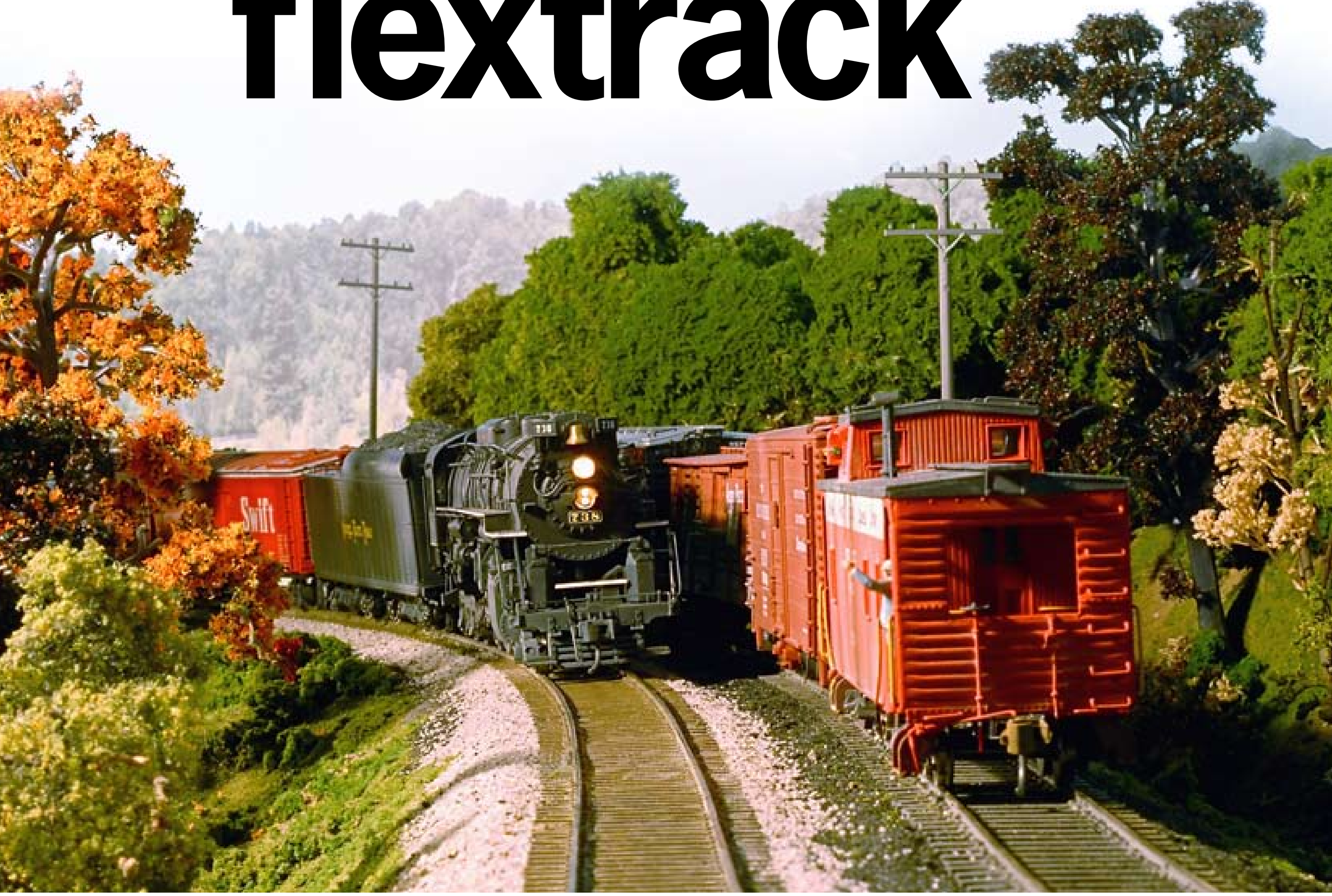
Noises also originate directly from locomotives and rolling stock. If you really want to enhance your on-board sound systems, you must also minimize the noise from these sources. See "Hush those cars" on page 26.

Bob found that ballasting the track had little effect on transmission of noise to the subroadbed, regardless of the roadbed material used.

The roadbed system you use will have a major effect in damping and isolating the unwanted noises. Experiment on your own with these materials. Perhaps you will find others that work even better. RRT

Bob Kingsnorth began model railroading with a Lionel set when he was 6, then switched scales when Kix breakfast cereal started giving away HO cars as a promotion. Many boxes of cereal later, he and his wife Carolyn retired to Central Point, Ore., where he models the freelanced Southern Transcontinental RR. He has two grown children.

Make the most of flextrack



This finely detailed HO track is Micro Engineering flextrack. Here it's on a long fill leading to a trestle over Coal Creek at Veedersburg, Ind., on Tony Koester's Nickel Plate Road layout. The main line, to the left, is superelevated so the onrushing Berkshire can maintain track speed. The passing track on the right remains flat.

Superelevated curves, easements, fills, roadbed cross sections, and painting and ballasting track

By Tony Koester/Photos by the author

There was a time when I thought the best way to achieve realistic track was to handlay it. Yes, it may be easier to achieve a flowing track alignment by building the track, especially the turnouts, from scratch (see "Customize track the easy way" on page 38), as you're not constrained by what's commercially available.

What we often give up when we handlay track, however, is the detail molded into plastic ties. We don't have to; The Proto 87 Stores (proto87.com) sells everything from scale spikes to tie plates. But I can't imagine handlaying all eight scale miles of my HO scale Nickel Plate Road St. Louis Division's main line, not to mention many more scale miles of yard and industrial track, to that standard.

It's about compromises

If we're willing to spend a little extra time being careful how we arrange commercial track components, we can save a lot of time without sacrificing a pleasing and realistic appearance. Moreover, with today's flextrack we can have tie plates and four spikes per tie, overcoming the drawback of handlaid track, with its highly visible spike heads in every 6th or 7th tie.

(Caveat: There is no "universal solvent." My good friend Perry Squier is modeling the down-on-its-heels

Pittsburg, Shawmut & Northern, featured in *Great Model Railroads 2009*, which apparently didn't spend a nickel on tie plates. His handlaid track's lack of this detail was therefore not a liability, but an objective!)

We also need to consider the roadbed and subroadbed the track is attached to. Simply plunking flextrack down on a sheet of plywood or thin piece of roadbed is unlikely to achieve a realistic right-of-way.

Realistic roadbed

Railroads know that the key to good track is good drainage, which means the railroad is elevated well above the surrounding terrain, often on fills, as shown in **fig. 1**. The cross-section of a typical railroad roadbed, shown in **fig. 2** on the next page, reveals the desired thickness and slope of various parts of the roadbed system. Note the ditches on either side.

Mainline track was typically ballasted with about a foot of crushed rock or gravel between the ties and subgrade, whereas sidetracks were often laid directly on the subgrade. The typical subgrade was a tamped bed of cinders reclaimed from steam locomotive ash pans.

This means the main line, or "high iron," was elevated about a foot above other tracks, especially in the popular steam-to-diesel transition period. See **fig. 3**. This is about 1⁄8" in HO.

I prefer Homasote roadbed for its ability to hold spikes, and California Roadbed (www.homabed.com) offers milled Homasote, which it calls HomaBed, in various widths and thicknesses, including 1⁄8" and 1⁄4".

I glue unbeveled 1⁄4" HomaBed along the track centerlines outside of yards, which gives me enough vertical height to add ditches on either side of the tracks even in level areas. I then add a layer of 45-degree beveled 1⁄4" HomaBed along the main and 1⁄8" beveled road-bed elsewhere, as shown in **fig. 4** on page 31.

Following a suggestion from *Model Railroader* executive editor Andy Sperandeo, I bought HomaBed with a 45-degree slope (as opposed to the 60-degree slope it offers), which allows more rock ballast to be piled up against the roadbed. This increases ballast costs, but provides a thicker mass of ballast for the glue to adhere to.

My friend Bill Darnaby uses 2" extruded-foam insulation board for the subroadbed on his HO scale Maumee Route. He then shapes the ditches with a hot wire and raises the main line on 1⁄8" cork roadbed, as shown in **fig. 5**. He applies thin strips of masking tape along the flextrack's outer edges to superelevate curves.

Fig. 1 High and dry. Railroads know that the key to good drainage is keeping the track elevated well above the surrounding terrain. This photo shows the same area as on the opposite page before the scenery was added. As you can see, the terrain slopes down and away from the tracks.

Where there are turnouts off the main line, I glue an 18" length of 1⁄4" HomaBed to the sidetrack roadbed and taper this to the level of the siding using a Surform tool. This means that a crossover in the middle of a passing track will cause the siding to ramp up to the turnout and then drop back down again. See **fig. 6** on page 32. Both turnouts and the ramps are usually ballasted with crushed stone or gravel to the elevation of the main track, but exceptions aren't hard to find.

If you're sure you won't be spiking down any rails, you can accomplish the same thing by adding a layer of cork, Vinylbed, or other material under the mainline ties to raise them the desired scale foot. You still need to create the slope between the ballasted main line and the unballasted siding or spur, and California Roadbed sells tapered ramp sections (shims) to make this easier.

Easements and curves

Track realism and performance are both compromised without easements. An easement is a decreasing-radius

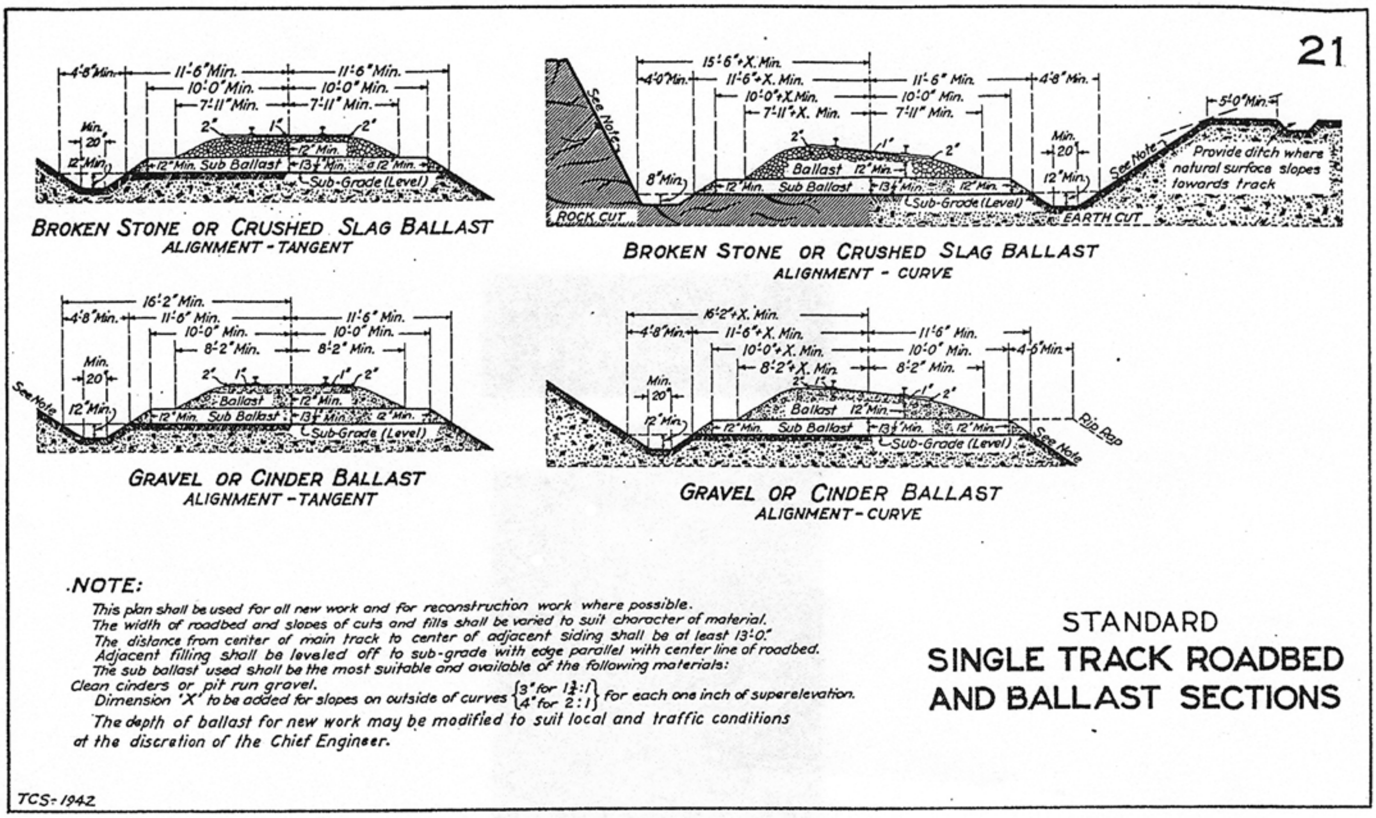


Fig. 2 Prototype plans. This cross-section of a typical railroad right-of-way shows the foot of rock ballast as well as the slope and width of the subgrade and ditches. This diagram is from a New York Central engineering book.

Fig. 3 High iron. Tony elevates his main track (foreground) ½" above the subroadbed, which is high enough to allow for drainage ditches along the right-of-way. Passing tracks are elevated ⅜", or about a scale foot lower than the main.

curve that connects tangent (straight) track to a curve of constant radius. Easements avoid suddenly jerking the train from a straight path into the curve, and they work as well on a model railroad as on the prototype.

Superelevation is the raising of the outer rail on a curve so that a train leans, or banks, into the turn like an aircraft, reducing the side forces on the rail. Although superelevation isn't needed on a model railroad curve, it adds considerable realism.

Fortunately, both are easy to achieve without any elaborate calculations. The key is to plan for them, especially easements, before gluing down an inch of roadbed. I've found it's not necessary to be mathematically rigorous about the amount of easement or superelevation. I simply offset the desired curve about 3⁄8" from the approaching tangent track and then connect the centerlines with a bent yardstick, as seen in **fig. 7** on the next page. The goal is an easement about the length of your longest car or perhaps half a car length longer. Even if you use sectional track, you can insert a length of flextrack at the start and end of curves to create realistic easements.

For superelevation, I glue 1⁄16"-thick basswood strips (such as Campbell's profile ties) end to end around the outer edge of the curve so that the flextrack ties are propped up on them. I lay these strips from the start of the entrance easement to the end of the exit easement. After the yellow glue has dried, I sand them smooth, reducing the thickness from full height down to a featheredge throughout the length of the easement.

For me, the small amount of extra work is more than repaid when I watch a train lean into the curve.

Curving flextrack

Some commercial flextrack has one rail so loosely attached to the ties that handling it is akin to holding a snake. Other flextrack, notably Micro Engineering's, is very reluctant to curve. I prefer Micro Engineering's weathered-rail track because it looks more realistic, is easier to repaint and weather if desired, and shows scribed measurement marks easily, but it's even a little harder to bend.

It turns out that this very stiffness of Micro Engineering's track is an asset once you learn a trick that my friend John Rogers taught me. Find a scrap piece of plywood about 40" long (longer than a piece of flextrack) and about a foot wide. Attach a 1 x 2

Fig. 4 Layered roadbed. Tony uses a base layer of 1⁄4" unbeveled HomaBed and laminates it with HomaBed with 45-degree beveled edges on the main line. He uses 1⁄8" beveled HomaBed for sidings. The top photo shows the gradual ramp down to the siding elevation, which is obviously lower at the road crossing (also see fig. 3 on the opposite page). Tony applies a plaster fillet between the roadbed and ditch to create the desired contour (bottom).

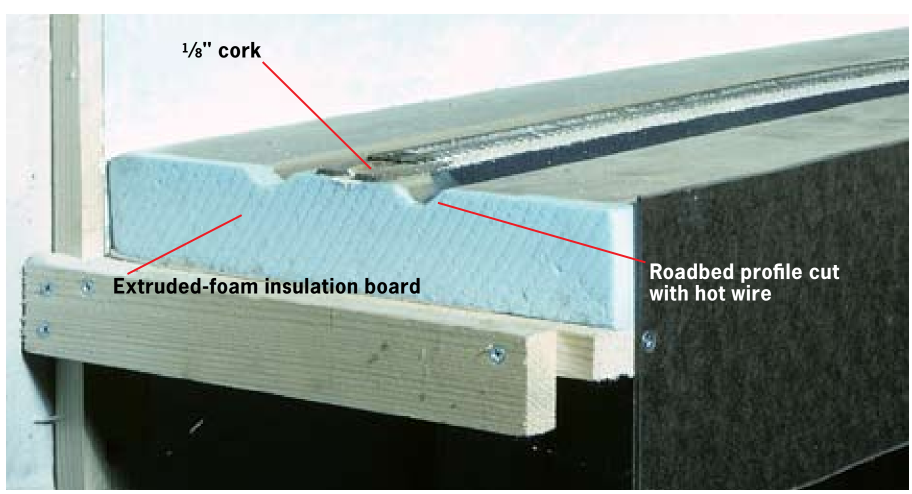


Fig. 5 Foam and cork. Bill Darnaby used 2" extruded-foam insulation board on his HO scale Maumee Route layout. He then glued 1⁄8" cork under mainline track and cut the roadbed profile with a hot wire foam-cutting tool.

Fig. 6 Crossover ramps. **Crossovers are usually at the main line's higher elevation, so ramps at both ends of the siding turnout descend to the siding's height. Tony uses a Surform tool to taper an 18" length of ¼" roadbed.**

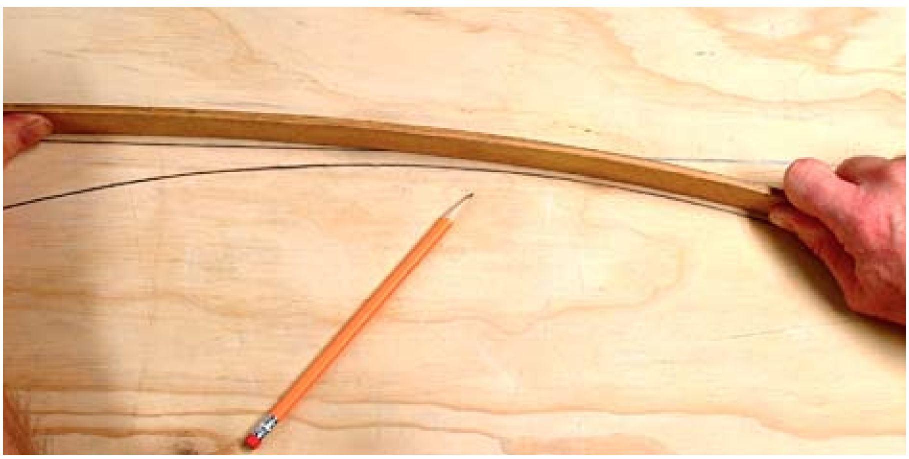


Fig. 7 Easy easements. **A wooden batten strip's natural bend approximates a spiral easement between a tangent track that's offset about ⅜" from the curve radius and the circular arc. The easement should be at least as long as your longest car and maybe half a car-length longer.**

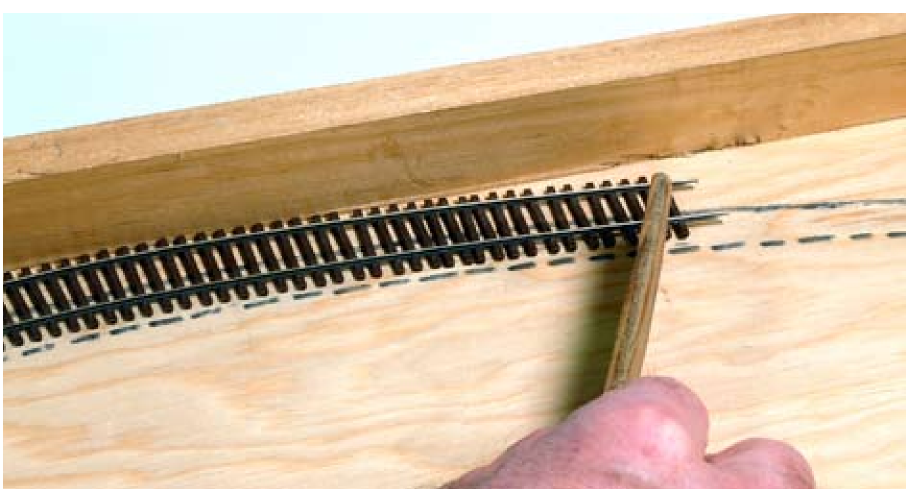


Fig. 8 Bending the iron. **John Rogers developed a technique for bending Micro Engineering flextrack. He rubs the tie ends with a flat stick, thus pushing them into a radial alignment and curving the track to the desired radius.**

backstop (fence) along the back edge. Draw the centerline of the desired radius a half-tie width (just over 4 scale feet) in front of this backstop. Place a length of flextrack against the backstop and, using a flat strip of wood (the end of a paint stirrer will do fine), gently rub the front edges of the ties from both ends in toward the center, as shown in **fig. 8**. This will slowly shift the inner ends of the ties so that they point toward you, which will drag the rail into an arc.

You'll find that the entire length of flextrack doesn't assume the desired arc, so brush the ties in the section that hasn't curved with the flat stick one way or the other until it begins to take shape. You'll soon get the hang of it.

The result will be a curved section of track that roughly approximates the desired curve. In the process, you'll have loosened all of the ties to the point where you can make final adjustments with your hands and eyes to achieve a smooth arc.

One caveat: If you follow Bill Darnaby's advice (in the November 1997 issue of *Model Railroader*) to cut the ribs between the ties, remove every 6th or 7th tie, and then respace the remaining ties to resemble lighter-duty sidings or industrial spurs, you'll want to curve the track before you loosen the ties. Otherwise, the battering motion will strip off many, perhaps most, of the ties. This is especially true with code 55 track, which has a very delicate molded spikes.

Bonding track to roadbed

Chuck Hitchcock took pains to tell us that we should use DAP clear adhesive caulk when bonding flextrack to roadbed in the August 2003 issue of MR. I couldn't readily locate the recommended DAP product and used first a colored plain caulk and then a substitute clear adhesive caulk. Big mistake!

I then ordered a case of the DAP clear adhesive caulk that Chuck recommended through my local lumberyard. As Chuck reported, the DAP product holds the track in place without the use of securing tacks, even on superelevated curves.

I found that I didn't have to pre-bend the rails on curves at the ends of each section of flextrack. But I think this was due mainly to the use of highly flexible code 55 and 70 rail and my 42" minimum curve radius. For curves much below, say, 36", or for heavier rail, I would probably pre-curve the rail ends with finger pressure to be sure there are no kinks between track sections.

I prefer not to solder the rail joiners to the rails, as the rail needs room to expand and contract with benchwork expansion and shrinkage. But where I suspect an alignment problem could occur, I solder the joiner to the rails.

Painting and weathering

I'm willing to give a complex, difficult project maybe 30 seconds to resolve itself before I lose patience. The folks who approach me with great ways to make, say, a highly detailed deciduous tree in a few hours quickly discover that my eyes have glazed over as I consider the two thousand such trees I need by this weekend.

That logic also applies to weathering track. I therefore get a spray can of Floquil's Rail Brown and blast away at everything within several inches of the track. [Make sure you have adequate ventilation and wear a two-stage respirator. – *Ed.*] For side and yard tracks, which get far less maintenance than the high iron, I then mist on some flat gray primer. I remove the paint from the railheads as soon as I can after applying it, before it has fully hardened. It's then time to ballast the track (see next section).

When the ballasting is done, I drag a Floquil Rust enamel paint marker (a felt-tip pen filled with paint, shown in **fig. 9**) along the sides of the rail to coat both the rail and tie plates. There was a lot of rust back in the days when refrigerator cars were cooled with ice, which rusted everything along the track as it melted and drained from the cars. Even the ties looked rusty!

The paint flows only when the tip is depressed, and it typically takes quite a few cycles to get the paint to flow the first time. I occasionally use a Railroad Tie Brown marker to coat a few ties to show the NKP is replacing old ties at a regular clip. And I simulate grease droppings (which became more pronounced in the diesel era) and metal brake-shoe residue with Bragdon Enterprises weathering powders.

Fig. 9 Simple weathering. Tony uses Floquil's Rust enamel paint marker to simulate rust on the rails and tie plates. He uses the same firm's Railroad Tie Brown marker to suggest some ties have been replaced.

Fig. 10 Spreading ballast. Tony uses a disposable foam paintbrush helps to push the ballast off the rails and ties. He reports that moving it sideways – parallel to the rails – works better than a normal brushing motion.

Ballasting track

I noticed Pelle Søeborg's ballast seemed more realistic than most, and I read that he used Arizona Rock & Minerals (rrscenery.com) stone ballast. He blended some other stuff into it, which frankly sounded like a bother for 500 feet of main line. But I bought a bag of no. 138-2 CSX/Southern Pacific/Wabash HO ballast and – despite misgivings when I looked at a sample of the ballast – gave it a try.

The problem was its salt-and-pepper appearance. I didn't recall so much contrast when walking along the NKP main line as a kid and later as a railfan. But I spread some along my main line as a test and shot some photos. To my surprise, I really liked what I saw. I just wasn't sure why. Then it dawned on me that the darker grains of this quarried stone looked like the shadows cast by the sun. Less directional and less intense model railroad lighting – I use fluorescent fixtures – doesn't create such shadows.

After spreading the ballast on the main or cinders elsewhere, I brush the ballast off the ties with a disposable foam brush, as seen in **fig. 10**. I then spray the ballast with a light mist of 70-percent isopropyl alcohol. When it's visibly soaked, I dribble in a 50/50 mix of water and Elmer's white glue. After the wet sheen is gone, I look for ballast still atop the ties or on the base of the rail and brush it off with my finger, keeping a rag handy to clean the material off of my hands.

The flextrack alternative

I'll close with a comment about track cleaning: If you must use an abrasive pad, as I do to remove paint from railheads, use a very fine-grained one, and do so only parallel with the track, not across it. Those pads can actually cut tiny grooves into the rail, which become good places for dirt and oxides to accumulate.

As you can see, the care taken up front arranging commercial track components will result in a realistic looking model railroad. You can even have tie plates and four spikes per tie, just like the prototype. RRT

Maintain standards for zero derailments

The National Model Railroad Association's standards allow models from different manufacturers to operate on any make of track.

Uniform dimensions ensure equipment interchange for smooth and reliable operation

By Jim Hediger
Photos by Bill Zuback

Maintaining standard dimensions is one of the most important aspects of building a model railroad. These precise measurements specify the width of the track (gauge) and the spacing of the wheels on the axles so our trains can run on the track. Any variation in the relationship between the track and wheelsets will lead to derailments.

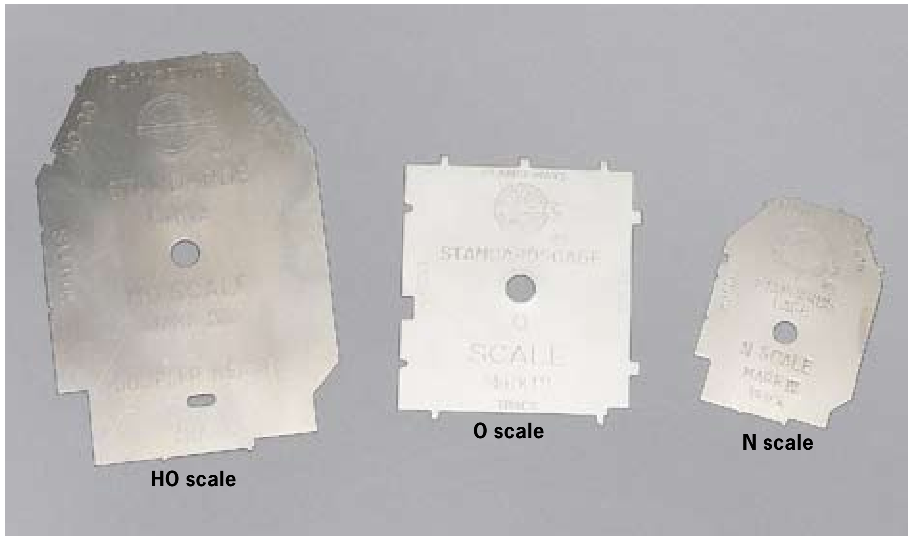


Fig. 1 Standards gauges. Sheet-metal gauges help modelers check and adjust track and wheels to National Model Railroad Association standards.

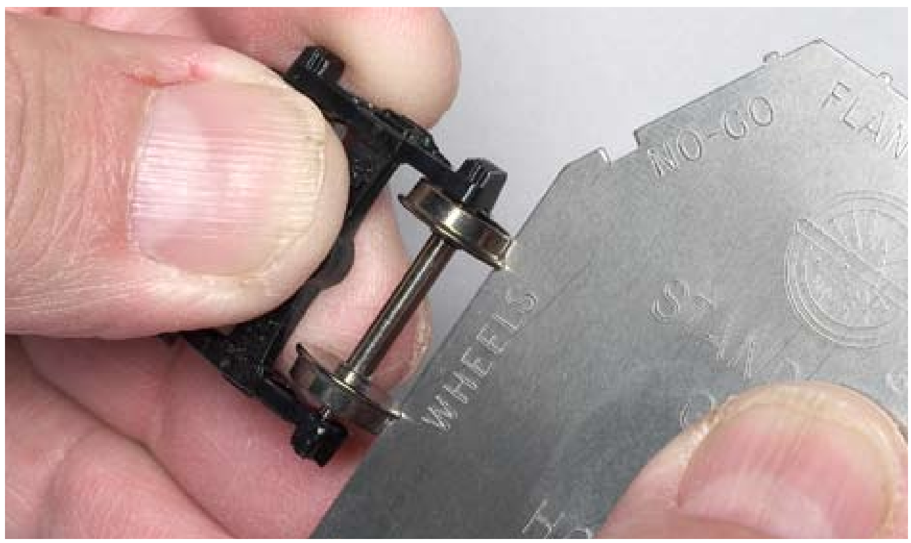


Fig. 2 Check wheel gauge. A pair of notches in the left side of this NMRA HO scale Mark IVb gauge measure the spacing of the wheels in an RP-25 wheelset.

Historical background

When the scale model railroading hobby began in the 1920s, it was primarily a scratchbuilding activity. Few commercial parts were available and modelers made their own wheelsets and handlaid track. By the 1930s, a few early manufacturers began selling scale rolling stock kits, but there was little chance of one modeler's equipment operating on any other layout. Standards were a minor concern for the early toy train makers, as most made their own track and set wheelset dimensions to suit.

An organizational meeting of about 75 modelers, mostly from the Midwest, was held in Milwaukee over the Labor Day weekend in 1935. The group's objective was to create an organization to develop standards that would make interchange possible between model railroads. This meeting marked the beginning of today's National Model Railroad Association (NMRA).

The early NMRA standards were developed between 1936 and 1945. This initial committee work was so well done that much of its basic data remains in today's standards. Some additions and revisions have been made, but the NMRA standards continue to benefit today's modelers.

The NMRA standards

The NMRA standards and accompanying recommended practices are available as PDF files published on the Web site www.nmra.org.

The NMRA's basic dimensional information is divided into two major categories. A *standard* covers only the critical dimensions that are mandatory for interchange. Information on less critical items is designated a *recommended practice*.

The NMRA standards gauge

The NMRA offers sheet-metal gauges to make it easy for modelers to check their track and rolling stock for conformance to the standard dimensions. See **fig. 1.** These handy tools are available from the NMRA and hobby dealers in sizes for HO, O, On3 (and OO), Sn3, HOn3, and N scales.

The HO and N standards gauges are shaped like a clearance diagram with some extra notches and small tabs around its perimeter. Labels are stamped on the gauge to indicate what dimensions each portion measures.

Critical wheelset dimensions

The flanges on a wheelset that's too wide will catch on any switch point, turnout frog, crossing, or rough rail joint it passes over. Likewise, a narrow wheelset's flanges will snag on any guardrails it may encounter.

Proper use of the NMRA gauge will immediately indicate if a wheelset conforms to the standard wheel spacing. The gauge includes two rounded notches along one edge labeled WHEELS, and both wheel flanges should drop right into them as shown in **fig. 2.** These notches measure the back-to-back spacing of the wheels. If the flanges don't fit easily, the wheel spacing needs to be adjusted on the axle until they do.

Most HO plastic wheelsets can be easily adjusted by gripping the middle

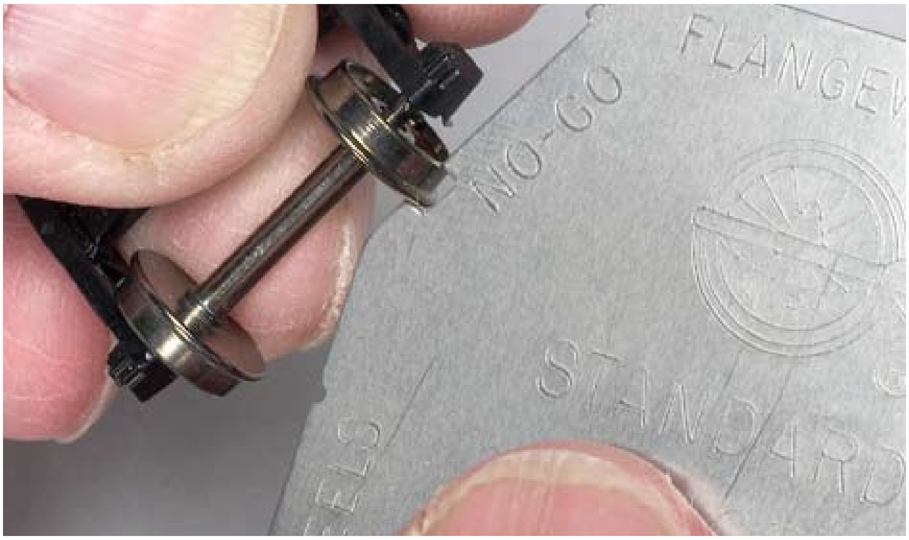


Fig. 3 Tread width. **Narrow wheel treads may have problems passing smoothly over switch frogs, so this No-Go notch checks for the standard tread width.**

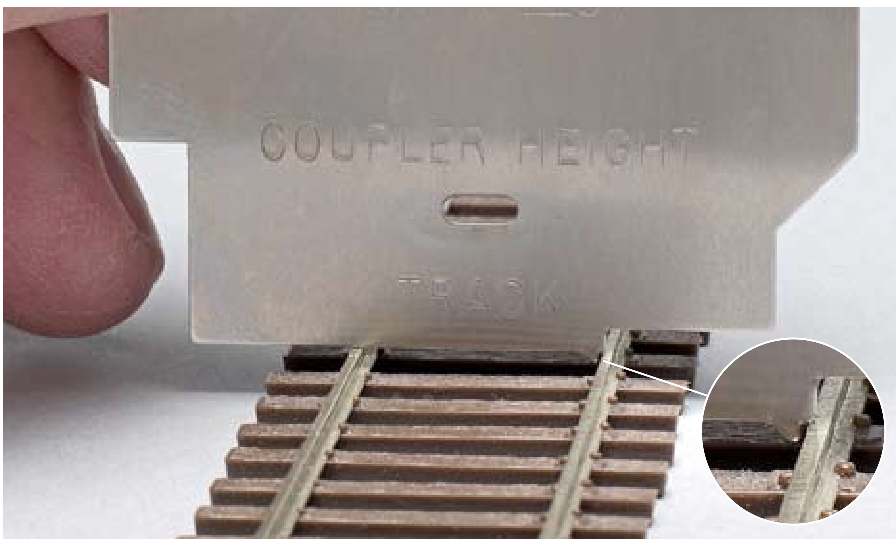


Fig. 4 Track gauge. **A pair of pins check the spacing (gauge) of the rails, while a small step alongside the right-hand pin indicates if the gauge is too wide.**

of the axle with pliers and using your fingers to twist a wheel in or out along the axle. Just be careful to keep the pair of wheels centered on the axle. A wheel press may be needed to adjust metal wheels mounted on metal axles.

The width of the wheel tread can be checked with the NO-GO wheel slot in the gauge. See **fig. 3.** The wheel tread should be just wide enough to span this slot in the gauge, or it may be too narrow to pass smoothly over the gaps in switch frogs.

Track dimensions

The remaining notches and pins on the NMRA gauge check specific track and turnout dimensions. Note that the pins have different widths, so be careful to use the proper ones for each dimensional check. It's a good idea to turn off the power before checking any track with the sheet-metal gauge.

A special pair of pins marked TRACK are found on the bottom edge of the NMRA gauge. The one on the left is a single pin that fits against one rail. Its opposite number on the right is a stepped pin that should fit snugly on the opposite rail with the small step on top of the railhead as shown in **fig. 4.** If the pin lands on top of the rail, the track gauge is too narrow; or if the step falls inside the railhead, the track gauge is too wide. Either way, some adjustment is needed.

Critical turnout dimensions

The spacing of the rails in a turnout is critical, so the NMRA gauge has two special sets of pins to measure the point spread and flangeways.

The pins labeled POINTS check the gauge between the inside of the switch point and its opposite stock rail. In addition, the width of these pins checks the spacing between the back of the open point and the adjacent stock rail. See **fig. 5.** This dimension must be maintained along the entire length of each switch point, and the point clearance can't be less than this pin's width. Switch points should be sharpened to produce a smooth transition for the wheels as they move onto the point from the stock rail.

A set of pins on top of the gauge labeled FLANGEWAYS measure the check gauge, or the spacing of the guardrails adjacent to the switch frog. If the guardrails are spaced properly, both pins will drop in between them as seen in **fig. 6.** Even with gentle pressure toward the frog, the gauge pin should still clear the point of the frog.

Guardrails shift a wheelset sideways by contacting the back of one

Routine inspections

Regular inspections are a fact of life for prototype railroaders who are always on the alert to spot mechanical problems that may affect their train or any other neaby movement. Most of these routine visual checks are made by operating and maintenace employees who are trained to catch small problems before they can turn into a catastrophic failure on the road.

I do similar routine inspections whenever I operate my Ohio Southern. By listening and observing the way my locomotives behave, and how the cars ride over the line, I can spot all sorts of potential problems like dirt or debris on the track, loose or shifted track joints, and many other items that need occasional adjustment or cleaning.

In most cases, it takes only a few seconds with a track cleaning block, pliers and a few spikes, or a needle file to restore things to normal. More involved repairs are marked with a sticky note stuck on the side of the railroad as a "slow order" for the passing trains. Keeping up with these minor maintenance adjustments keeps the entire railroad up to NMRA standards, and that pays dividends in overall performance. *J.D.H.*

wheel flange to pull the opposing flange away from the frog point. If this check gauge is too narrow, the guardrails can't do their job and keep the wheel flanges from hitting the frog point. On the other hand, if the check gauge is too wide, the wheel flanges will ride up across the guard and wing rails, possibly causing a derailment.

The width of the frog's flangeways are also important, so there's a pin on the NO-GO side of the gauge to check this dimension. See **fig. 7.** This pin should just span the opening between the frog and the wing rails without dropping between them. The depth of the frog's flangeways can be checked with either of the two FLANGEWAY pins.

Recommended practices

As part of its standards work, the NMRA established a series of recommended practices to cover major components that offer many variables. Known as RPs, these items include minority scale modeling; curvature and rolling stock relationships; turnout dimensions; car weight, and many others. Though these items are not standards, these recommendations reflect considerable engineering work by NMRA committee members that modelers can use to advantage.

Interchangeability

Through the years, the NMRA has continued to refine and modify its standards to include new developments in the hobby. Its biggest challenge is to maintain the founders' original intent of product interchangeability as new technical advancements are introduced.

Some of the world's top engineering talent can be found on the NMRA's standards committees, and their work has produced many innovations that certainly benefit all modelers. Two of their best known projects are the rounded profile of the RP-25 wheel contour in July 1966, and DCC (Digital Command Control) in the 1980s.

Despite all of the later innovations, the performance of trains on our model railroads still depends upon the proper use of the basic wheel and track standards introduced just before World War II. RRT

More on our Web site

To see Jim's demonstration of how to use the NMRA standards gauge, go to www.ModelRailroader.com. and look for it under Online Extras.

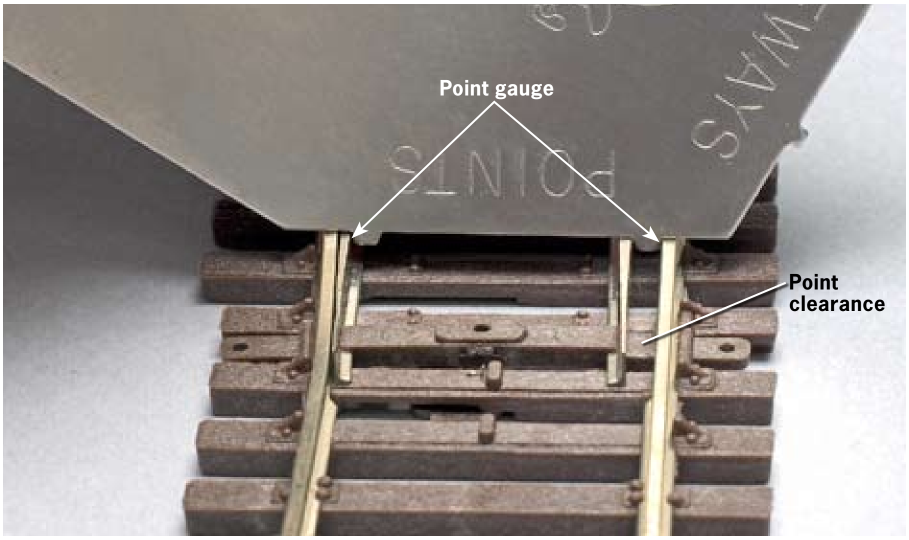


Fig. 5 Point spread. These pins check the gauge at the switch points and measure the clearance between the open point and adjacent stock rail.

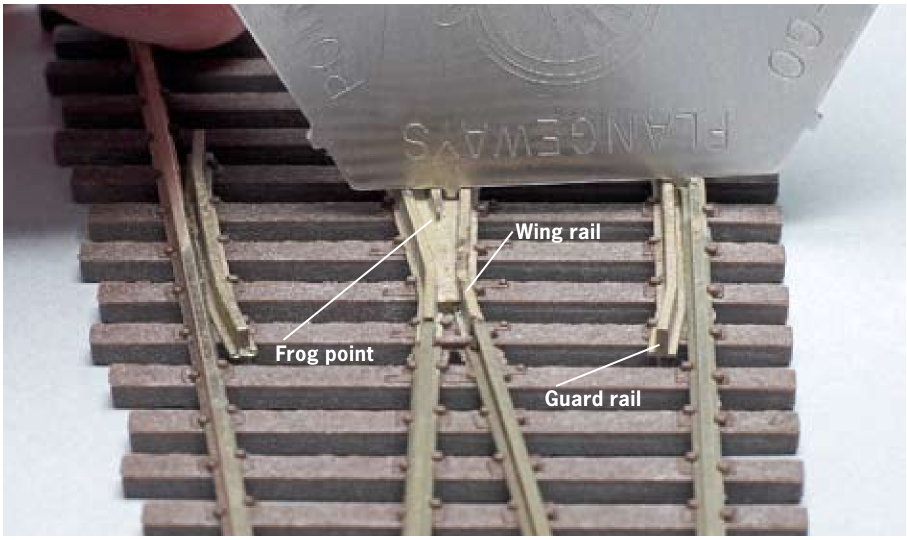


Fig. 6 Check gauge. Properly spaced wing and guard rails guide the wheelsets smoothly through the frog and keep the flanges from hitting the frog point.

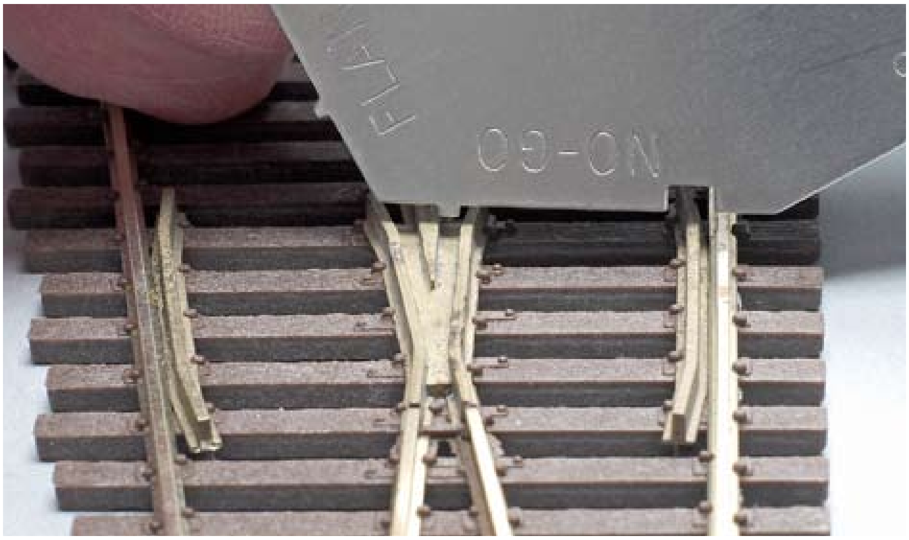


Fig. 7 Frog flangeways. A separate pin is provided on the NMRA gauge to measure the flangeway width within the switch frog.


By curving Central Valley plastic turnout tie strips, Tony Koester fit no. 8 turnouts in a yard ladder originally designed for no. 6 turnouts. Tony uses a variety of kits and components to make smooth-flowing, realistic track.

Customize trackwork the easy way

Kitbashing track and turnouts with tie strips and detail parts

By Tony Koester
Photos by the author

Handlaying track, especially turnouts, is a relaxing and enjoyable part of building a model railroad. One of my true joys is watching a passenger car or freight car smoothly roll through the switch points and frog of a turnout that I've just finished building.

A compliment I often hear about handlaid track is that it seems to flow more smoothly than ready-to-run turnouts and flextrack. When handlaying track you can build turnouts to fit seamlessly into the railroad's geometry, rather than letting turnout geometry dictate the track alignment.

When I built my HO scale Allegheny Midland in the 1970s, there weren't many ready-to-run track choices, especially where turnouts were concerned, so handlaying track was a necessity. I handlaid the main line with code 83 rail, which approximates the relatively heavy 132-pounds-per-yard rail typical of Appalachian coal roads in the first- and second-generation diesel eras. There were no commercial turnouts back then made with .083"-high rail, and the selection of code 70 turnouts for off-main use was limited.

Things are considerably better today, but there are situations where "kitbashing" a curved turnout or yard ladder, as shown above, or building one using a smaller rail size will come in handy. (I am using codes 55 and 70 rail for my current Nickel Plate Road HO layout.)

Electrical considerations

Model turnouts face one challenge not shared by their prototypes: the need to provide an electrical path from the power supply to a locomotive motor. With the advent of increasingly popular Digital Command Control (DCC) systems, the ante has been raised a bit.

Keeping the two flavors of electricity (positive and negative voltages) separate isn't hard, as shown in **fig. 1**. But if the points aren't insulated from each other and the frog isn't isolated from the rest of the turnout, a wide, out-of-scale gap is required between an open point and the adjacent stock rail. Otherwise, a metal wheel passing through the open side of the switch might brush against the open switch point and cause a short circuit.

Manufacturers such as Atlas, Micro Engineering, Peco, and Walthers now make turnouts labeled "DCC friendly." The label is a bit of a misnomer, as "old-style" turnouts and wheelsets built to National Model Railroad Association standards should work together just fine.

But I prefer the look of points spaced more realistically close to the stock rails, so I use an insulated switch rod, isolate the frog with four gaps, and connect each stock and adjacent point rail to the appropriate bus wire. I do this on older commercial turnouts and when handlaying turnouts. No short can occur, so the point–stock rail gap can be smaller.

The penalty is that the frog is now electrically dead. Short frogs (typical of lower-numbered turnouts) can often be left dead; longer ones can be powered through single-pole double-throw (SPDT) switch-motor or toggle- or slide-switch contacts, as in **fig. 2**, if short-wheelbase locomotives stall or stutter on them.

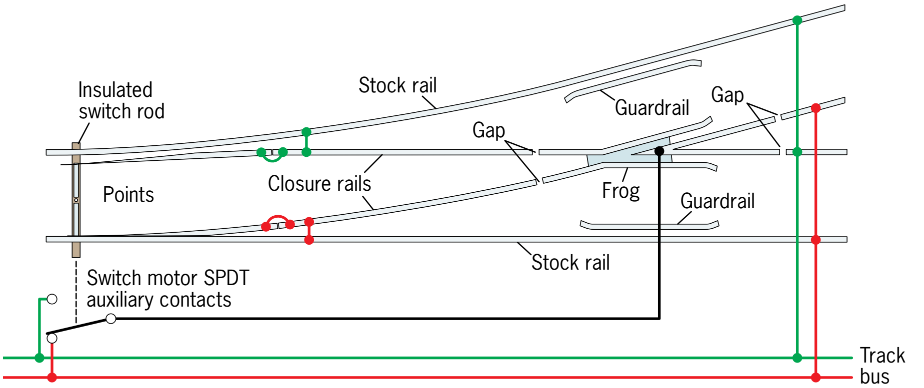


Illustration by Rick Johnson

Fig. 1 Turnout wiring. If both points are of the same polarity and not insulated from each other, they can cause a short between the open point and adjacent stock rail as a metal wheel rolls through. Isolating the frog allows each point to be the same polarity as the adjacent stock rail. The frog can then be powered through the single-pole double-throw (SPDT) contacts on a switch motor.

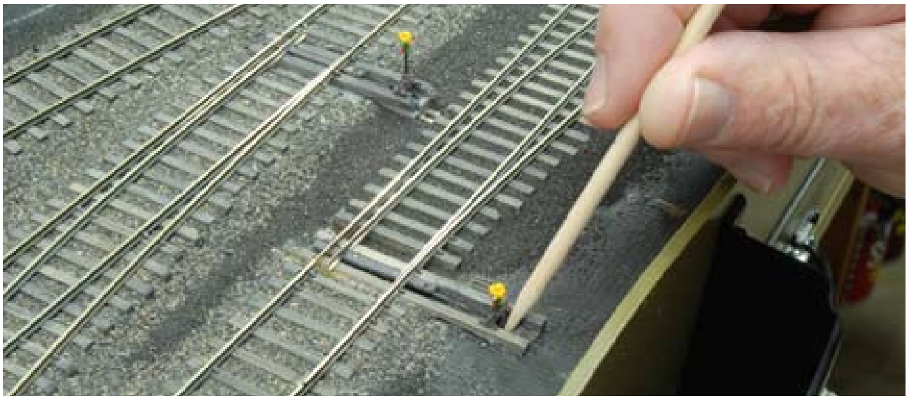


Fig. 2 Using micro slide switches. Perry Squier uses SPDT micro slide switches to mechanically move the switch points while electrically changing the frog polarity. Perry glues an N scale NJ International switch stand to the shortened "knob," but operating crews are cautioned to use an uncoupling stick to push on the switch knob, not the switch stand.

Turnout kits

When a commercial turnout won't do the job, a kit may fill the void. Many companies offer a wide range of tracklaying products. Here are a few that I've used.

Fast Tracks (www.handlaidtrack.com) is an innovative company that offers just about everything a modeler needs to make handlaying track as easy as assembling a kit in scales and gauges from N through On3. Among its products are jigs to help you accurately file switch points and frog point rails. The company also has full-size turnout jigs; just drop in a few printed-circuit (PC) board ties and the rails, solder the whole works together, and then glue on a set of laser-cut wood switch ties before snapping off the ends. Modeler Ted Pamperin had never handlaid any track, yet quickly built all of his straight and curved turnouts, including those in **fig. 3** on page 40, using Fast Tracks jigs.

The Proto 87 Stores Web site at www.proto87.com is an eye-opener, even if you're not modeling your layout to fine-scale standards. Owner Andy Reichert is a proponent of prototype authenticity down to the smallest detail. Along with handlaying supplies, the firm also sells superdetailed turnout kits.

I reviewed Central Valley Model Work's HO turnout kits in the December 2003 *Model Railroader*. You can also find more information on the company's turnout kits and track tie strips on the Web at www.cvmw.com. Adding a highly detailed frog casting from Details West (www.detailswest.com) in place of the kit frog is easy to do; the molded-in pad for the frog aligns the part properly. Details West also sells guardrail and point sets.

Manganese-insert frogs

On prototype railroads, most mainline turnouts in high-traffic locations have manganese-steel insert frogs. The rails approaching the frog are bent into a diamond or oval shape to accommodate the steel casting. This casting provides longer life for the point of the frog, which is battered by every passing wheel.

Although no commercial turnouts come equipped with such frogs, Details West makes manganese-insert frog castings for no. 8 frogs in code 70 and nos. 8 and 9 frogs in code 83. These frogs can be retrofitted to commercial turnouts or used with turnout kits, tie strips as in **fig. 4** on page 40, or handlaid turnouts.

Fig. 3 Fast Tracks turnout kits. Ted Pamperin uses Fast Tracks jigs and some of the firm's other tracklaying materials to build straight and curved turnouts for his HO scale model railroad. Building this layout marks Ted's first experience handlaying track, and the Fast Tracks jigs helped him quickly achieve great-looking and smooth-performing results. Ted Pamperin photo

Fig. 4 Frog castings. Tony uses Details West code 70 no. 8 manganese-insert frog castings for mainline turnouts. They drop accurately into place on Central Valley tie strips. Cyanoacrylate adhesive (CA) and four spikes hold the new frog in place. The frog feeder wire is soldered into the outside crotch of the frog and connected to an SPDT toggle or slide switch or switch motor contacts.

Fig. 5 Gluing plastic tie strips. Tony uses DAP clear adhesive caulk to install Central Valley tie strips. He glues down CV's mainline tie strips out of the end of all three routes of a turnout tie strip. The rail anchors will keep the rails aligned through the turnout until everything is spiked in place. The anchors make it harder to brush ballast off the ties and tie plates if the track is ballasted beforehand.

Fig. 6 Spiking rail. Spiking pliers, which have T-shaped grooves cut in the jaws to get a better hold on a track spike than needlenose pliers, are handy tools for tracklaying. Spiking through the hollow plastic ties of the Central Valley tie strip requires a few seconds of steady pressure. Use your free hand to steady the the pliers near the tip or you'll risk bending a lot of track spikes.

Fig. 7 Filing switch points. Tony makes his switch points by filing lengths of Micro Engineering code 70 rail. The gauge side of the tip of each point is tapered as well as chamfered to ensure it won't catch a passing wheel flange. The base of the point rail must be burnished to a bright sheen to ensure it will easily accept solder.

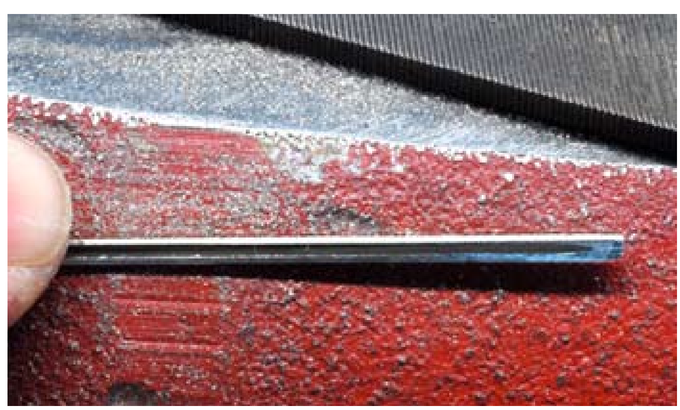


Fig. 8 Finishing the points. The outside of the point is then filed to a flat surface that fits against the stock rail. Tony notches the base of the stock rail to for an interference-free fit for the point. The points are continuous with the closure rails, without hinges, so they are powered from feeders soldered to the closure rails.

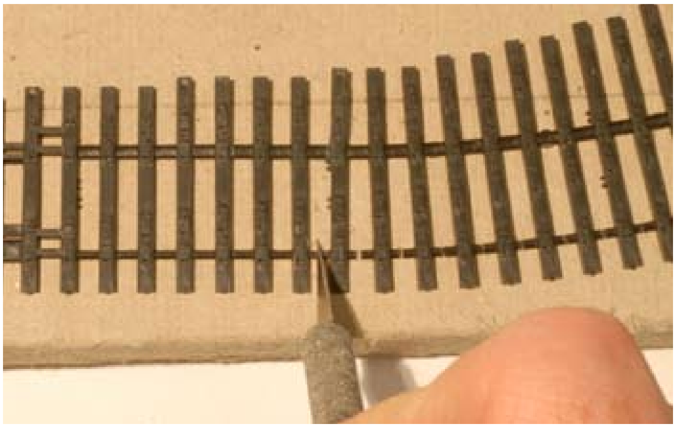


Fig. 9 Curving turnout tie strips. As with its track tie strips, Central Valley's turnout tie strips can be curved by using a hobby knife to cut through the outer plastic rib between the ties. Completely remove this rib for curves toward the outer web. Leave the rib intact near the frog to maintain its straight alignment. You can purchase CV turnout tie strips separately or as part of a turnout kit.

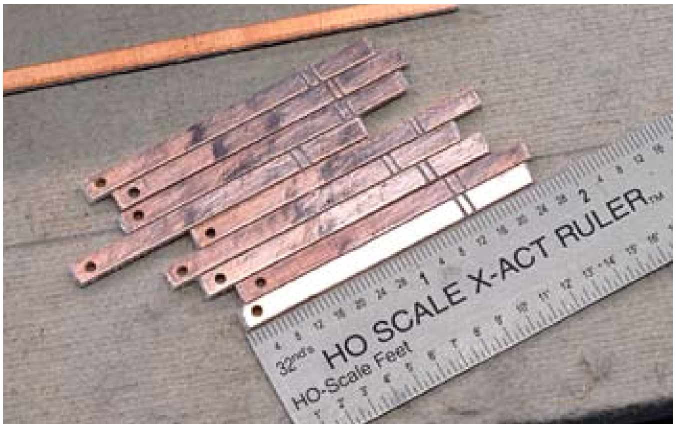


Fig. 10 Switch rods. Using printed-circuit board strips from Clover House, Tony cuts switch rods 13 scale feet long, so they reach the point-actuating wire from the switch motor outside the rails between the headblock ties. He drills a hole in one end to for the piano-wire actuating rod from a switch motor, and files gaps in the top surface to break the electrical path between the points.

Turnout terminology

As defined by railroad engineering departments, a turnout is the complete assembly of rails, frog, switch, and guard-rails. A switch is the moving assemblage of points and switch rod (not throw bar). You can't "throw a turnout," as it's spiked down. Nor can you have, say, a "no. 8 switch," as the switch assembly does not include the frog. Operating department railroaders always refer to a "switch," as that's the part they move to change the route through the turnout. Railroad civil engineers generally refer to a turnout, as do published speed restrictions through the diverging route of a turnout of a given frog number.

The turnout's frog number is the ratio of rail spread beyond the frog. A no. 8 frog (or turnout) has the rails spread 1 foot apart at a distance of 8 feet from the point of the frog. A no. 4 turnout is therefore sharper than a no. 8 turnout. – *T.K.*

No one best solution

I enjoyed handlaying the visible track and scratchbuilding turnouts on the Allegheny Midland. So why am I not handlaying the track on my new Nickel Plate Road layout?

Actually, I did handlay some turnouts, but connected them with Micro Engineering's weathered flextrack. I like the look of Micro Engineering track, as it has two tie plates and four spikes on every tie. It also doesn't have a large spike head sticking up every sixth or seventh tie, as handlaid track usually does.

Moreover, a better way of "sort of" handlaying turnouts and even track has emerged: Central Valley Model Works tie strips. Using tie strips is easier than true handlaying, as the molded-in tie plates automatically align and gauge the rails. Simply apply a thin coat of DAP clear adhesive caulk to your roadbed, center the ties above the track centerline using the tiny "gun sights" molded into the end ties, and refine the tie alignment by sighting along the tie plates by eye before the adhesive caulk sets. A tie strip installed on my layout is shown in **fig. 5** on the opposite page.

Central Valley now offers three types of plastic track tie strips as well as turnout tie strips from nos. 5 through 9. The mainline tie strips feature 8'-6" ties with molded-in tie plates on every tie. They also have one or two rail anchors at every fifth tie; peen over the projecting prongs of each anchor to hold the rail in place.

As you can see in **fig. 6**, the hollow ties readily accept Micro Engineering small spikes, which I use to secure the rail to the turnout tie strips. Most code 70 and 83 and some code 55 rail drops right in.

I use Micro Engineering's weathered rail and Details West castings for the turnouts on my layout. You can see how I make my own points with code 70 rail in **figs. 7 and 8**.

Like the track tie strips, the CV turnout tie strips can easily be curved. As shown in **fig. 9** above, snip through the outer rib except alongside the frog pad, which should remain straight. (On North American railroads, frog rails are normally straight on both sides; there is no left- or right-hand frog.) I initially designed the yard ladder shown on page 38 for "straight" commercial no. 6 turnouts, but I achieved a more flowing alignment and increased the frog number by curving Central Valley no. 8 turnout tie strips.

When I shot that photo of the yard, I installed switch rods made from Clover House (www.cloverhouse.com) PC board strips, shown in **fig. 10**. I had yet to extend the headblock ties, upon which a switch stand will rest. My current focus is to get my railroad fully operational before worrying about scenic details, and that includes detailing turnouts.

I think you'll find, as I have, that you need to have several tricks up your sleeve as you address the need for turnouts of various sizes and alignments. I hope one or more of the methods described here will help you find a technique that will work for your layout. RRT

"Bulletproof" track wiring means built-in reliability to prevent future trouble. Andy Sperandeo uses the feeder system shown here to make sure there's a reliable current path to every piece of rail on his layout.

Bulletproof track wiring

Tips on building in electrical reliability **By Andy Sperandeo/**Photos by the author

We have three expectations of model trackwork. We want it to look like the prototype, we want our trains to roll over it smoothly and without derailing, and we want it to provide a solid circuit for propulsion current and control signals. I'll focus on the last of these and show how to build in reliability as you lay track on your layout.

My recommendations are primarily aimed at wiring for Digital Command Control layouts, but in general they're also good practice for conventional DC wiring.

Feed every piece of rail

While I prefer to say things positively, as in "feed every piece of rail," the negative version of that statement may be helpful too: Don't trust rail joiners. Those little bits of folded metal might be good electrical connections when they and the rails are new, but there are many ways for them to fail. Corrosion, paint, glue, ballast, and movement (including expansion and contraction from temperature and humidty changes) all work against the rail joiner.

You *can* solder them, and I like to do that for smooth joints in curves and to assemble complex groups of turnouts. But I like to leave rail joints unsoldered in straight track, with a slight space between the rail ends to allow for expansion. (I use a space of .016" in my HO track, the thickness of a National Model Railroad Association standards gauge.)

The most positive approach, in my experience, is to feed every length of rail. If you do this as you lay the track it's not that much extra work, and you'll probably never have to worry about track connections again for the life of the layout. Potential problems such as voltage drop through rail joints and the relative inefficiency of rail as a conductor (compared to copper wire) simply won't be in play.

Unobtrusive feeders

Feeding every length of rail requires a lot of feeders, which I don't

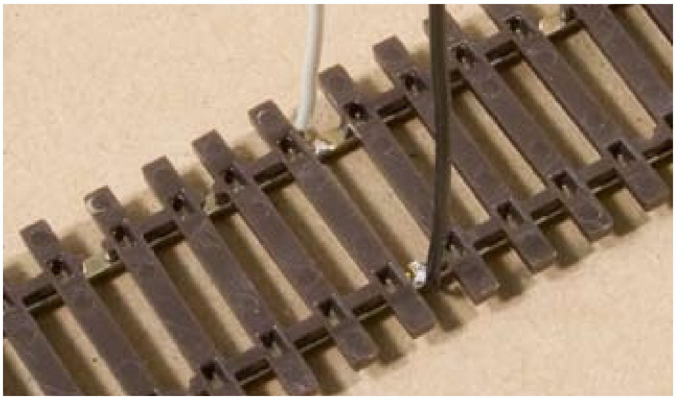


Fig. 1 Feeder under rail. A straightforward way to conceal feeder wires is to solder them to the bottom of the rail before laying the track. On flextrack like this from Atlas, you'll need to remove the plastic spacers between a pair of ties to expose the rail for soldering.

Fig. 2 Dog-leg feeder. Solder small-diameter solid wire to the base of the rail, as here on *Model Railroader's* Wisconsin & Southern HO layout. Solder neatly and it's safe to do this on the gauge side of the rail, so all feeders can be opposite the aisle or normal viewing position. MR staff photo

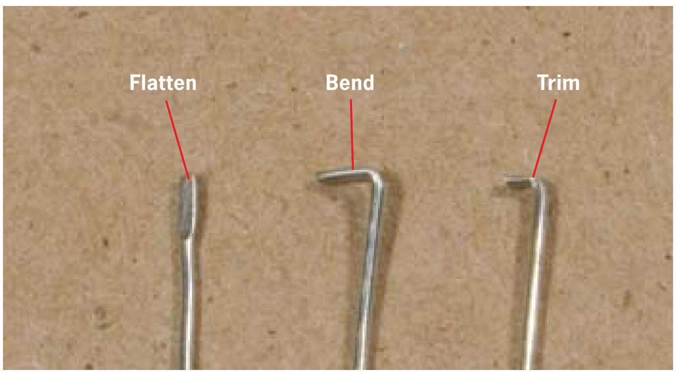


Fig. 3 Spike-head feeders. Starting with 22AWG bare solid bus wire, Andy flattens the end of the wire with pliers as on the left. Then he bends the flat end over (center) and trims it to about the size of a track spike's head (right) before tinning it and soldering it to the rail.

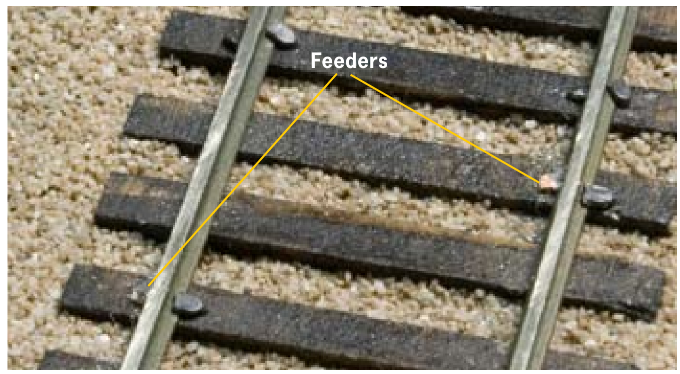


Fig. 4 Hard to find. Andy left one of his spike-head feeders unpainted so the bare metal would show up in the photo. It's inside the rail on the right. When painted, these feeders are hard to tell from track spikes, and Andy sometimes has trouble finding one when he wants to show them to visitors.

mind as long as they aren't obvious in the finished track. There are at least three good ways to make feeder connections hard to see.

Underside. Solder feeder wires to the underside of the rail before laying it, as in **fig. 1**. On flextrack and ready-to-use turnouts you'll neet to cut away some of the plastic runners between the ties to expose the bottom of the rail for soldering.

This method of hiding feeders is effective, but the wires should go straight down through the roadbed under the rails. That means you'll have to locate and drill holes for the wires before putting the track in place. It also means the feeders end up completely buried in your ballasted track. I prefer the other two approaches described below.

Backside. Solder conventional "dogleg" feeders, as shown in **fig. 2**, on the side of the rail away from the viewer. Drill holes straight down next to the rail, either through ties or between them, on the back side of the rail as seen from an aisleway or normal point of view. Using small-diameter, solid wire, typically 22 AWG, bend the top of the feeder into a dogleg shape that will lie flat along the base of the rail, then solder it there.

This puts half the feeders on the gauge side of the rail, where the wheels run, and model railroaders have often been warned against doing this. It's true that gauge-side feeders can cause trouble if you use thick wire and leave big blobs of solder. But if you use small wire and no more solder than necessary, wheels with NMRA RP-25 or even standard flanges will never know the feeders are there.

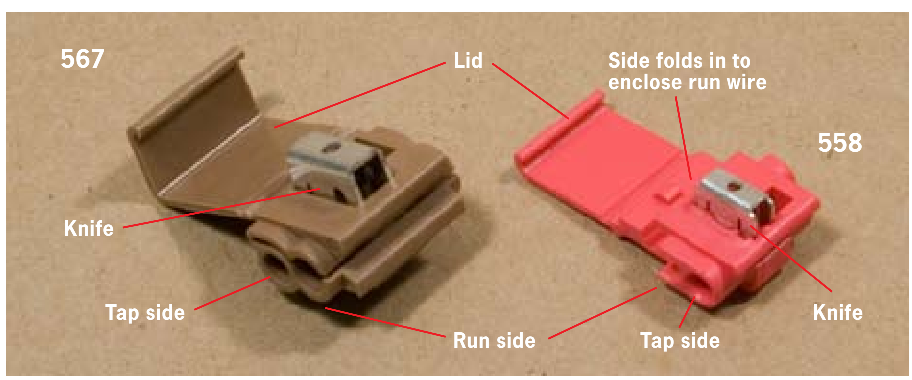


Fig. 5 Suitcase connectors. Scotchlok insulation displacement connectors (IDCs) let you make reliable, insulated connections fast.

Fig. 6 Squeezing the knife. Andy uses Robo-Grip cam-action pliers to press the connector's knife flush with the body of the connector. The knife cuts through the insulation and into the metal conductors, bridging the two wires together.

Fig. 7 Snapped shut. After the knife is pressed flush, the "suitcase lid" can be closed to cover the bare metal and safely insulate the connection. The brown no. 567 connector can handle wire sizes up to 10AWG on the through or run side, making it ideal for bus connections on many DCC layouts.

Fig. 8 Feeder extensions. The no. 22 bare feeder wires come through the bottom of the plywood subgrade, where Andy splices them to 18AWG feeder extensions. Before making the connections, he doubles the bare wire back on itself and twists it so the connector will get a solid grip.

Fig. 9 Bus connections. Andy connects the 18AWG feeder extensions to 12AWG bus wires with no. 567 connectors. The white wire is the common rail bus and the black wires are separate buses for each signal block. The white tags identify the block buses by the signal number.

Spike-head feeders. This is my favorite method for handlaid track on wooden ties, but it works on flextrack too. It's also good for rail soldered to printed-circuit-board ties. Bend and flatten the end of a small-diameter, solid wire to resemble the head of a track spike as in **fig. 3** on page 43, tin the underside of the "spike head" ("tin" means coat it with solder flowed from the tip of a hot iron), and solder it to the base of the rail just where a track spike would be.

Once you touch up the solder joint with paint, the spike-head feeder will blend right into the track. They're so hard to see, I sometimes have trouble finding them to show to friends who want to know what they look like. Take a look at **fig. 4**.

After any soldering on track I clean up the flux residue with denatured alcohol and a used toothbrush. Then I paint the soldered area to match weathered rail or other track painting using black, brown, and gray acrylic paints mixed on the tip of a small watercolor brush. "Match" in this case means close is good enough.

I don't recommend soldering feeders to the bottoms of rail joiners, since my objective is to take rail joiners out of the electrical circuit.

Suitcase connections

Along with lots of feeders, feeding every rail requires lots of wire splices underneath the layout. It was obvious to me that stripping, splicing, soldering, and taping a lot of connections under the track wasn't how I wanted to spend my time. That led me to try insulation-displacement connectors, or IDCs. These are also known as "suitcase connectors" because of the folding lid that snaps closed over a completed connection.

I've enjoyed good results with 3M Scotchlok brand IDCs. They're fast and easy to install and completely reliable. I use the two sizes shown in **fig. 5** (page 43) for almost all connections, for both end-to-end and tee splices. The brown no. 567 handles 10 to 12AWG wire on the through or "run" side, and 14 to 18AWG wire on the single-ended "tap" side. The red no. 558 takes 18 to 22AWG wire on both sides.

The plastic body of the IDC holds two wires parallel while you force the connector's U-shaped, slotted metal "knife" through the insulation and into the metal conductors. The run side of the connector is slotted to fit over a wire that's already in place, like a bus wire. Neither wire has to be stripped, and the only cutting needed is to trim the tap wire to length.

You have to press the knife flush with the connector body to make the connections, and that takes plenty of leverage. While 3M sells a Scotchlok crimping tool for this job, it's rather expensive. I find that the Robo-Grip cam-action pliers shown in action in **fig. 6** work just as well for about a quarter of the price. Channellock pliers are almost as effective.

When the knife has been pressed home, the suitcase lid can be snapped closed on a neat, insulated, and secure

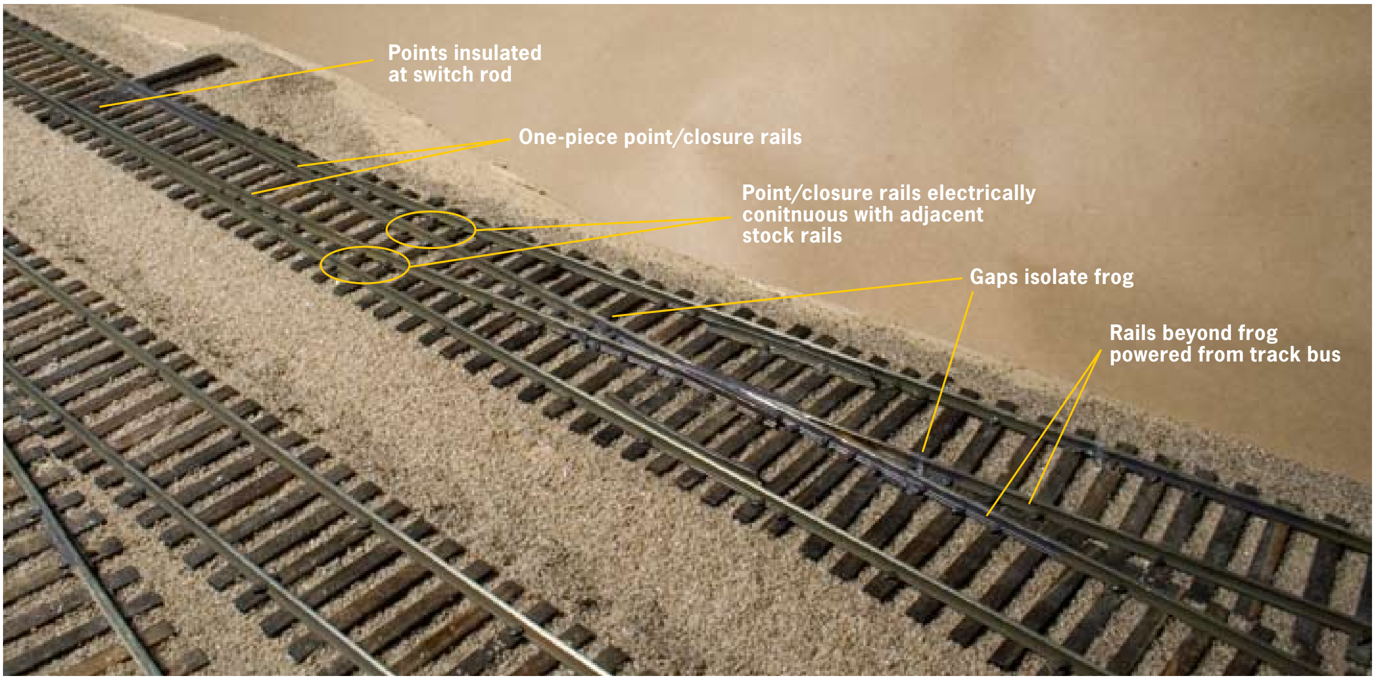


Fig. 10 Turnout wiring. Andy builds his own turnouts and wires them with isolated frogs and each continuous closure/point rail connected to the same bus wire as the adjacent stock rail. This way electrical clearance at the points is not an issue. The rails beyond the frog are also connected to the bus and aren't switched by the turnout.

connection as in **fig. 7**. I buy Scotch-lok connectors in bulk from online dealers like Mouser (www.mouser.com) – they're cheaper by the hundred. Smaller quantities can be purchased in the electrical aisle at hardware stores and home-improvement centers, or from Micro Mark.

Two-stage bus connections

Feeder wires are ideally of small diameter for neat, unobtrusive connections to the rails. Bus wires are ideally of large diameter to carry current for long distances around a layout without voltage loss. It makes sense to use an intermediate-size wire to connect the two, and that's practical because suitcase connectors make splices so fast and easy.

On my HO layout I use 22AWG bare solid bus wire for feeders, but they extend only far enough below the plywood subgrade to allow a no. 558 IDC to connect to an 18AWG insulated, stranded feeder extension wire, shown in **fig. 8** on the opposite page. The feeder extension runs a short way – I try to keep them to less than 12" – to splice into the 12AWG bus wire through a no. 567 IDC as in **fig. 9**.

You can run high DCC currents through smaller wire for short distances without voltage or signal loss, which is why I limit the distance between rails and bus wires.

More on our Web site

To see a video of Andy demonstrating suitcase connectors and other wiring tips, go to www.ModelRailroader.com and look under Online Extras.

Turnout wiring

Since I build my own turnouts, you can bet that they have what I consider ideal wiring. That means that the frogs are isolated, the points and closure rails are electrically continuous with the adjacent stock rail, and the rails beyond the frog have their own feeders and aren't dependent on the turnout for power. See **fig. 10**.

I operate my turnouts with Tortoise motors, so I use the auxiliary contacts to power the frogs. I even wire both sets of single-pole, double-throw contacts in parallel, so both would have to fail before the frog lost power.

The best thing about this wiring is that there are no dead sections in a turnout. This is especially important to me now that I'm installing DCC sound in my locomotives. Nothing spoils the realism of sound effects quicker than an interuption.

Because the points are continuous with the closure rails – the rail just bends – they don't depend on contact with the stock rail or through a rail joiner for power. And because the points are the same polarity as the adjacent stock rail, metal wheels can't cause short circuits if they brush the back of the open point. The point can lie closer to the stock rail than the NMRA standard for electrical clearance, which looks more prototypical.

You don't have to build your own turnouts to enjoy many of these advantages, but any hinged point is a weakness. If I were using commercial turnouts, I'd follow Lance Mindheim's suggestion in his article on page 6, and solder a small, flexible wire to each point that I could splice into the stock rail feeder or bus under the layout.

Dead frogs are also a potential weakness, although many of my friends have layouts that don't suffer control or sound interruptions on unpowered frogs.

The length of the frog is a factor. Only the smallest locomotives might stall on a no. 6 frog, but on longer (higher numbered) frogs the chance of stalling is greater. I've built some curved turnouts and crossovers with very long frogs, and I wouldn't want to risk leaving them unpowered.

Long-term satisfaction

By building in reliability we can prevent future troubles by eliminating the causes of potential failures. I won't promise that any wiring system will be completely maintenance- or trouble-free. However, I think the "bulletproof" approach I've described is about as close to that goal as we can practically come. RRT

How to mass produce hand-built turnouts

Prefabrication on the workbench is the key

By John Pryke/Photos by the author

John Pryke holds one of his mass-produced HO turnouts that's ready to install on his layout. The rails soldered across the top hold the turnout's parts in alignment until they're spiked down.

When it comes to realism, I'm convinced that handlaid track looks far better than any of today's commercial track. To me the visible grain and slight color variations of wood ties and weathered rail gives the closest appearance to the prototype. However, the biggest challenge in handlaying track comes from track plans that have many turnouts in yards or complex junctions. Here's a method I've developed to mass produce handlaid turnouts which is easy to use and produces excellent results every time.

Getting started

The first step is to determine the turnout sizes you want to use on your layout. I have some fairly tight space restrictions on my new HO scale layout, yet I want to run full-length heavyweight passenger cars and 10 to 12 car freights behind steam locomotives.

These criteria dictated my selection of no. 5 turnouts for most of my main-line and yard turnouts with a few no. 6s wherever they'd fit, and no. 4s for the yards and spur tracks.

Next I bought one commercial turnout in each size I planned to use. The size of the rail and whether these turnouts are left- or right-hand isn't important. I spiked each turnout to a scrap of Homasote and stretched a piece of tracing paper over it. After securing the tracing paper with thumbtacks, I traced the rails onto the paper by sliding a soft-lead pencil along the top corner of the rails, as seen in **fig. 1**.

I removed the paper and darkened in the pencil line with a fine tip, black permanent marker. I also marked the location of the frog point, as well as the bend between the points and the wing rails (also a line on each side of the frog). These rail lines can be seen from both sides of the thin tracing paper, creating left-hand and right hand images.

Using a copier, I made five copies of each side of the tracing paper to obtain right- and left-hand templates for each size of turnout. I build my turnouts on top of these templates. See **fig. 2**. Each template can be used to construct four or five turnouts before it needs to be replaced.

All of the dimensional Standards and Recommended Practices for turnouts in all scales are available as PDF files from the National Model Railroad Association's Web site at www.nmra.org.

Building the turnout

Figure 3 shows all of the rails and parts that go into one of my HO scale turnouts. I use weathered code 83 rail on my main line and code 70 for the sidings and yards. The weathering makes it easy to see my progress as the coating is removed as I file the various parts to shape.

I lay a piece of rail on the template and cut each piece to the correct length using a rail nipper (flush-cutting pliers that leave a square end on the cut rail). Then I lay the individual pieces of rail on the template and bend the curved pieces to shape.

Following the dimensions shown in the "Turnout parts" chart on page 48, I cut a frog plate from .002" brass that will join all four pieces of the frog. You'll also need four guardrail plates made from .002" brass, and a point spacer plate made from .005" brass. I made an insulated switch rod from a strip of $\frac{5}{32}$" x .030" styrene 1$\frac{3}{8}$" long.

Shaping the rails

Some of the rails are filed or bent to shape, as shown in **fig. 4** on page 48, so the parts will fit together with the proper clearances. These include:

- Both point-and-closure rails (straight and curved) must have their point ends filed to a smooth taper that fits tightly against the web of the adjoining stock rails. The opposite ends of these rails are bent to form the frog's wing rails.
- The frog rail ends must be filed to produce a smoothly tapered point to form the inside of the frog.
- The inside of each stock rail must have an indentation ground into its base so the tapered points fit snugly against the insides of the railheads.
- The weathering must be filed or cleaned with a wire-brush from the bottom of the various rails to expose clean metal where they'll be soldered to the brass reinforcing plates.
- The weathering must also be removed from the inside of the points where the point spacer plate will be soldered between them.

To do all this, I clamp the rail in a smooth-jaw vise and file it to size with a small hand-held file. I use the flat side of the file to taper and sharpen the points as shown in **fig. 4**, make the stock rail indentations; and to remove the weathering from the rail bases.

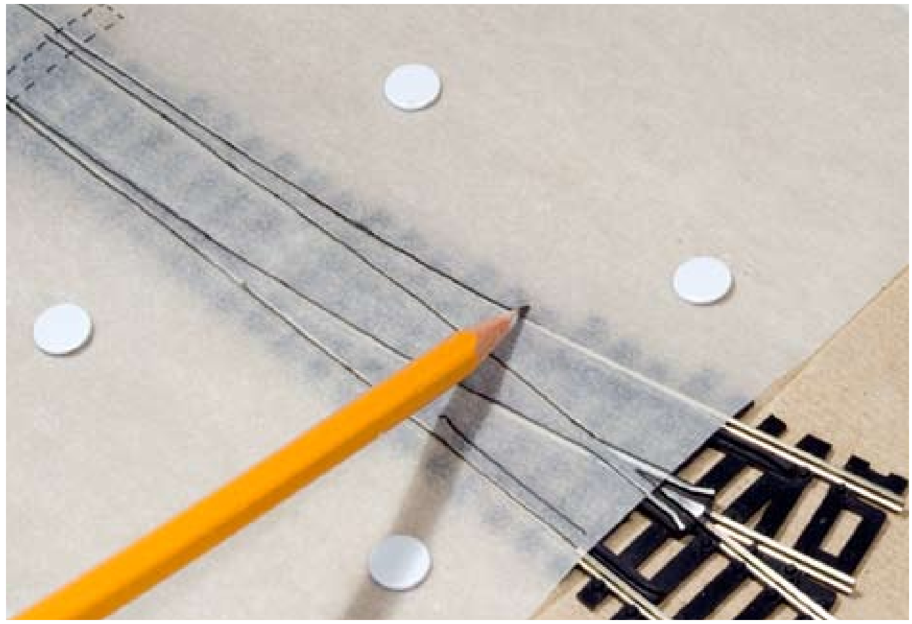


Fig. 1 Turnout tracing. John uses a soft lead pencil to trace the rails in a commercial no. 4 turnout he temporarily spiked to a piece of Homasote.

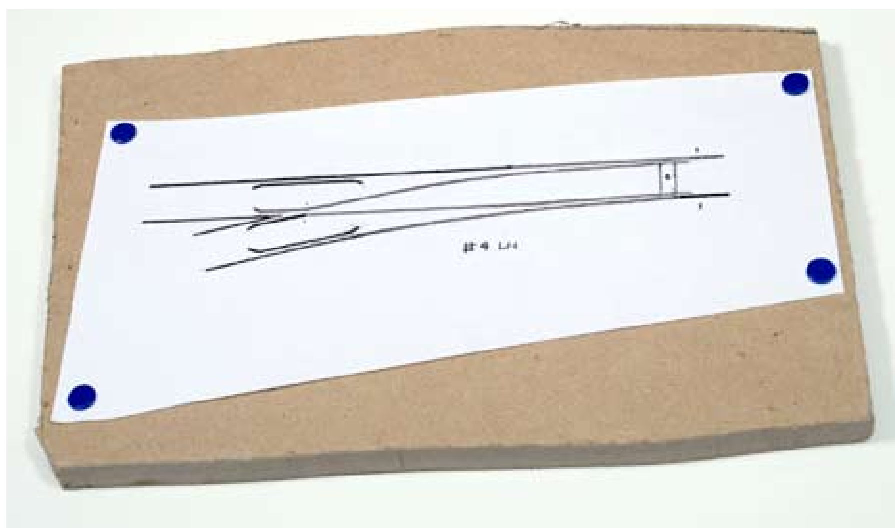


Fig. 2 Turnout pattern. After filling in the pencil lines with a fine-point marking pen, he made photocopies of the tracing to use as turnout assembly templates.

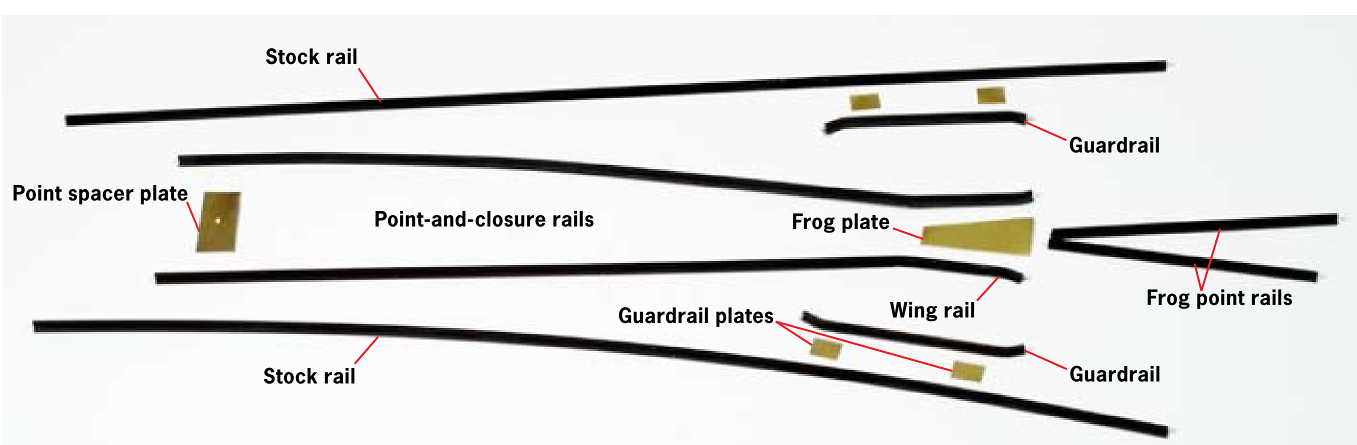
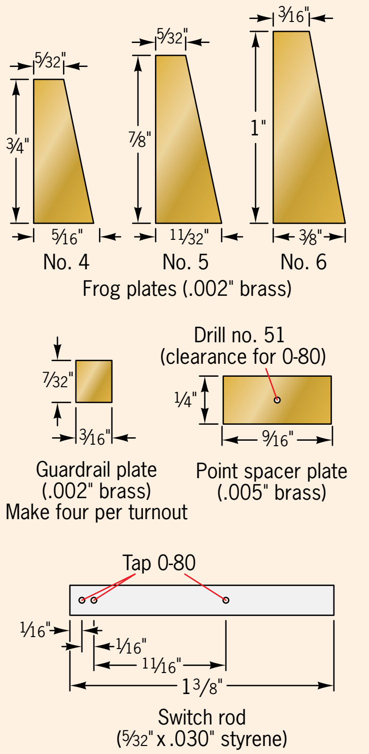


Fig. 3 Turnout components. This photo shows all of the components John fabricates for a single mass-produced turnout. Once everything is ready, he aligns and spikes the parts onto the template and solders the assemblies together.

Turnout parts

These templates can be used to cut the frog and guardrail plates for no. 4, 5, and 6 HO turnouts out of .002" shim brass. Note that the guardrail plates for all three sizes are the same. The switch rod is made from .030" styrene.



Illustrations by Rick Johnson

Length and quantity of HO scale turnout ties required

Tie no.	Size	No. 4	No. 5	No. 6
1	1¼"	5	5	5
2	1½"	11	11	13
3	1¾"	4	5	7
4	2"	6	7	8

Fig. 4 Shaping rails. **John clamped each point rail in a smooth-jaw vise so he could file it into the long, smoothly-tapered point needed for good performance.**

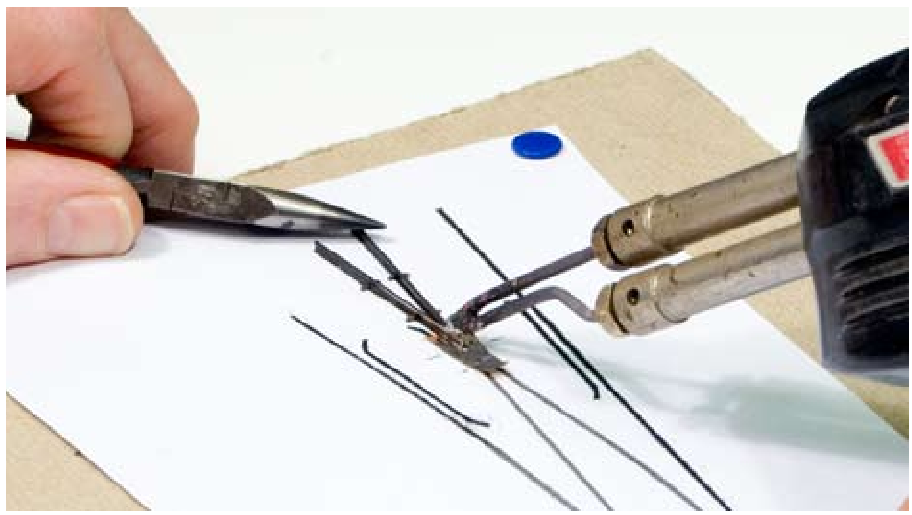


Fig. 5 Soldering the frog. **After he aligned and spiked both frog rails in position, John slipped the frog plate underneath and soldered everything together.**

Then I use the point of the file, or a wire brush in a motor tool, to remove the chemical weathering from the inside contact face of each point.

Assembling the turnout

Once I finish shaping the rails, I reassemble the pieces on the correct template fixed to a piece of scrap Homasote. I use large-headed spikes to hold the rail on the template. Micro Engineering medium or large spikes will do.

I start soldering the pieces together by tinning the areas where I filed the weathering off the bottoms of both stock rails, the guard rails, and the frog rails. Tinning is the process of heating the metal, applying flux, and then depositing a thin layer of solder on the surface.

I use a Weller dual-heat (100-watt or 140-watt) soldering gun, rosin paste flux, and thin rosin-core electronic solder for most of my turnout soldering, as shown in **fig. 5**. I also use a small tip in the gun. This delivers a lot of heat to a small spot, which is ideal for rail. Applying paste flux to the area to be joined ensures that the solder will flow easily and make a solid joint.

Next, I tin the frog plate and place it in its location on the template. Then, I spike the two frog rails onto the template over the rail lines, making sure their pointed ends meet evenly and rest on the frog plate in line with the rail marks. Once aligned, I solder the two frog rails together and to the frog plate as shown in **fig. 5**.

I spike the two stock rails onto the template, making sure that the plates are positioned under each guard rail location, and solder them into place.

Next, I spike the points and wing rails into place, making sure that the diverging curve between the point and wing rail matches the template, and that the wing rails fit properly on the frog plate. Using a National Model Railroad Association Standards gauge, I check the spacing of all of the rails, the clearances between both wing rails and the frog, and the alignment through the frog. See **fig. 6**. Then I solder the wing rails to the frog plate.

As shown in **fig. 7**, I test the frog by running a freight truck with wheelsets that match NMRA standards through it. If the truck's wheels pass smoothly through the frog on either route

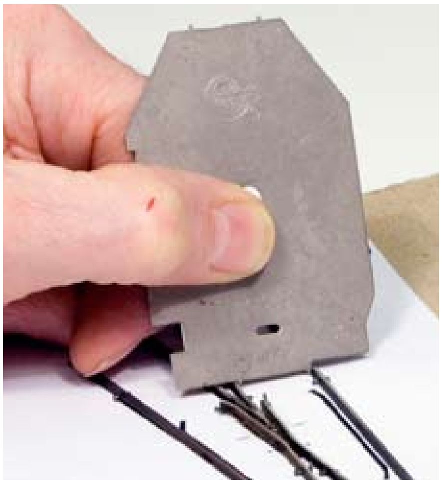


Fig. 6 Track gauge. **John uses a National Model Railroad Association Standards gauge to check the spacing between the rails along both routes.**

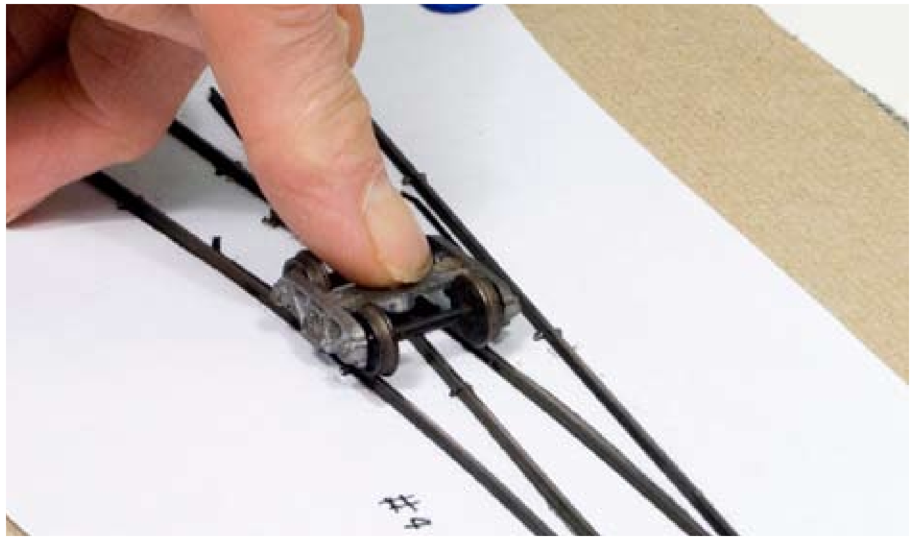


Fig. 7 Test the frog. **Rolling a good truck back and forth through the frog allows John to catch any irregularities before the guardrails are installed.**

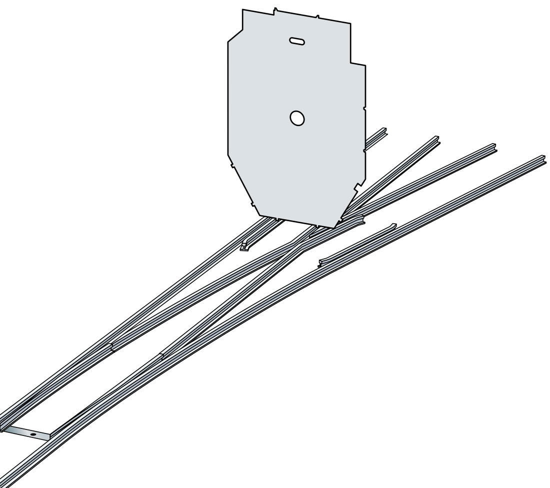


Fig. 8 Check gauge. **Measuring the check gauge is important to ensure the guardrails are spaced the proper distance from the frog they protect.**

Fig. 9 Soldering the points. **Installing the point spacer plate requires careful soldering to produce a clean, strong joint that clears the wheel flanges.**

(straight or curved), the frog is in good shape. If the truck derails or bumps its way through the frog, I make any necessary adjustments by filing the frog, moving either wing rail, or filing the tops of the frog rails.

Once the truck passes through the frog smoothly, I solder the guardrails to the guardrail plates. The proper spacing of the guardrails is very important and must match the check gauge pins labeled FLANGEWAYS on the top edge of the HO gauge. See **fig. 8**. Then I make one last check with the truck and the hardest part of building a turnout is over.

Finishing the points

To install the point-spacer, I spike both points to hold them away from the stock rails. Then I tin both edges of the spacer and the inside of each switch point. I slide the plate between the points and align it with the template. Sometimes I have to re-spike one of the points to obtain a snug fit.

I solder the spacer plate to each point as shown in **fig. 9**. The spacer plate should rest tight against the base of the rail, and the solder bead must be small enough to clear the wheel flanges. [Since these joints receive a lot of stress, Tix indium-based solder offers considerably more strength than ordinary solder. It's available from Walthers. – *Ed.*]

After the point assembly cools, I remove the spikes and test the throw and fit of each point against its stock rail. I've found that a little filing and bending may be necessary for a tight fit. I check it again with the NMRA gauge and run the truck through the switch in both directions. Then I clean the weathering off the tops of all the rail heads in the turnout.

Transferring the turnout

To transfer the finished turnout from my workbench to the layout I solder pieces of scrap code 100 rail across the turnout rails in three locations. See **fig. 10** on page 50. I cut three pieces of rail, one to fit across the stock rails before the points, one to fit across the middle of all the rails, and one to fit across the wide end. Next I tin the bottom of these rails with plenty of solder and position them so they're clear of the spikes that must be removed to release the turnout from the template. Then I solder the strap rails across the turnout.

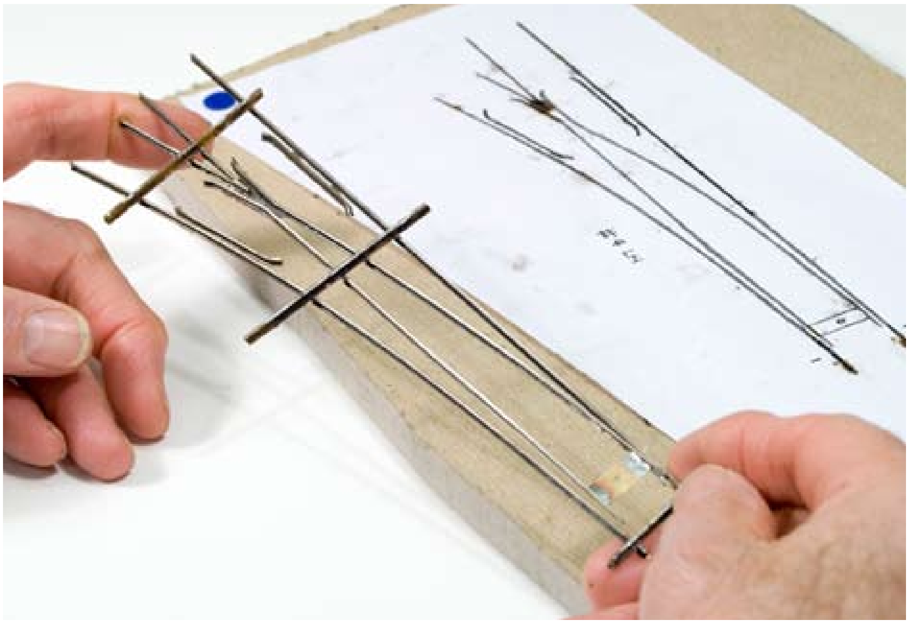


Fig. 10 Transfer straps. **Three straps made of scrap rail are soldered across the tops of the turnout's rails to hold it together during transfer to the layout.**

Fig. 11 Switch rod pivot. **John uses a modified round-head screw as a pivot that passes through the point spacer and is threaded into the switch rod.**

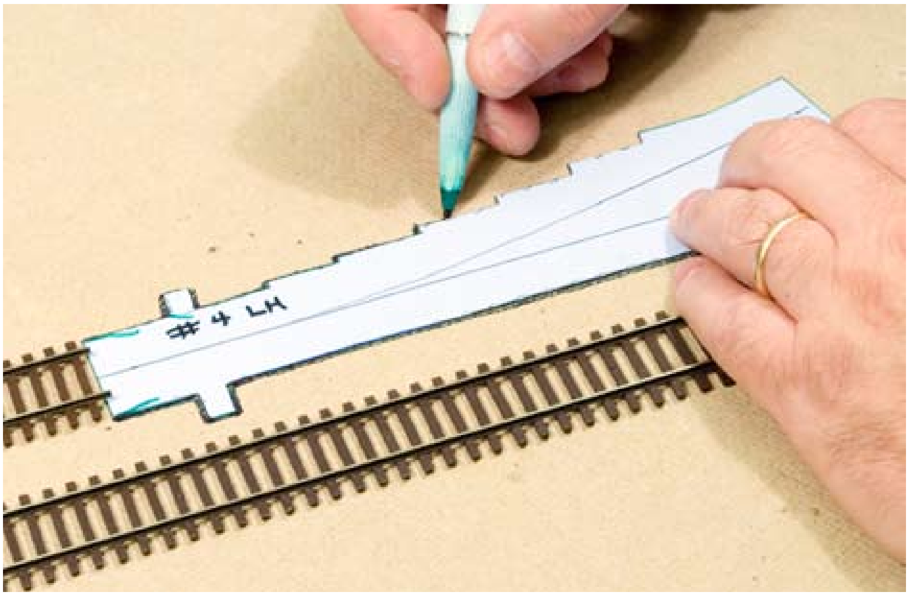


Fig. 12 Turnout template. **A template simplifies the work as John positions his mass-produced turnouts in yard ladders and other congested areas.**

After all the straps are securely attached, I use needlenose pliers to unspike the turnout so I can lift it off the template. Note that I leave the template on the Homasote so I can use it to build an additional three or four turnouts. Since the spike holes are already in the template, I save the spikes and use them again.

I make my insulated switch rod from a strip of 5⁄32" x .030" styrene 1⅜" long. I use a brass 0-80 x ¼" round-head screw for a pivot. I flatten the top of the head, but leave a slot deep enough for a screwdriver. Then I run the screw through a clearance hole in the point spacer and thread it into a tapped hole in the plastic switch rod, as shown in **fig. 11**.

After making sure that the switch rod can swivel freely, I add a drop of cyanoacrylate adhesive (CA) to the bottom of the screw to keep it from loosening. Then I trim the screw flush with the underside of the switch rod.

Positioning templates

To locate a turnout on my layout, I use a positioning template made out of posterboard, but heavy sheet styrene would also work. Like the assembly templates that I used to construct the turnouts, these can also be used over and over again.

Using one commercial turnout of each size as a pattern, I trace the outlines of their tie ends and switch rods on the posterboard. I also mark the track centerlines at the ends of each template. Then I cut out the patterns with a hobby knife. Note that each pattern can be flipped over to produce the shape of a right- or left-hand turnout. I've made several extra templates so I could lay out yards.

Site preparation

To use a position template I set it where the turnout will go and trace its edges with a fine-point permanent marker, as shown in **fig. 12**. I use a sharp chisel to cut out a shallow channel under the switch rod.

Next, I spread a thin coat of carpenter's glue over the area beneath the turnout, lay a set of long switch ties on the wet glue, align them, and press the ties down into the adhesive.

I cut my ties from basswood strips, 3⁄64" x 3⁄32" for code 83 rail, and 1⁄16" x 3⁄32" for code 70 rail. The difference in tie height allows the tops of each kind of rail to be level at transition joints. The "Turnout parts" list on page 48 shows the length and number of ties that will be needed for three different common HO turnout sizes.

After the glue dries and all the ties are fixed to the roadbed, I add ballast over the switch ties. I'm careful to keep ballast below the tie tops and out of the switch-rod channel, which I paint Grimy Black. If you model the steam era, leave a line of black cinders along the edge of the ballast as seen in **fig. 13**. Ballasting before the turnout is installed keeps glue and ballast out of the moving parts.

Installation

Next I set the completed turnout on the ballasted roadbed, **fig. 14**, check its alignment, and spike down the frog, followed by the frog rails, stock rails, and points, with Micro Engineering small spikes. [Those spikes may not be available right now, but Micro Mark no. 83517 spikes are a good substitute – *Ed.*] Note that the spikes on my closure rails stop four ties from the frog so the points can move easily.

Once the spiking is complete, I remove the strap rails by heating the top of each strap and gently pulling it off. Then I carefully file any remaining solder off the railheads. Finally, I test the turnout by rolling cars through it and filing off any impediments to smooth operation.

The final touches

The shiny rails in a turnout are created by the wheels of cars rolling over them. However, the wing rails, guard rails, and point connections have no running surfaces, so I paint them with Floquil or Polly Scale Grimy Black and Rust. See **fig. 15.**

I use the holes at the end of the insulated switch rod to attach a ground throw switch stand for manual operation. The same hole can also be used to connect a bellcrank leading to a switch machine or switch motor. Adding a slot in the channel under one end of the switch rod will accommodate the vertical actuating rod from a Tortoise switch motor.

Information on wiring turnouts can be found in Chapter Three of Andy Sperandeo's book, *Easy Model Railroad Wiring, Second Edition*.

The key to this mass-production technique is the use of templates to build the turnouts and position them on a layout. The templates provide uniform results each time. In addition, as you construct more turnouts and become used to the methods employed, your efficiency will improve, and you'll be pleasantly surprised by your capabilities. RRT

John Pryke is a veteran HO modeler who willingly shares his modeling expertise with others. He especially enjoys hand-laying track, modeling the steam-to-diesel transition era on his favorite New Haven RR., and hosting operating sessions on his layout.

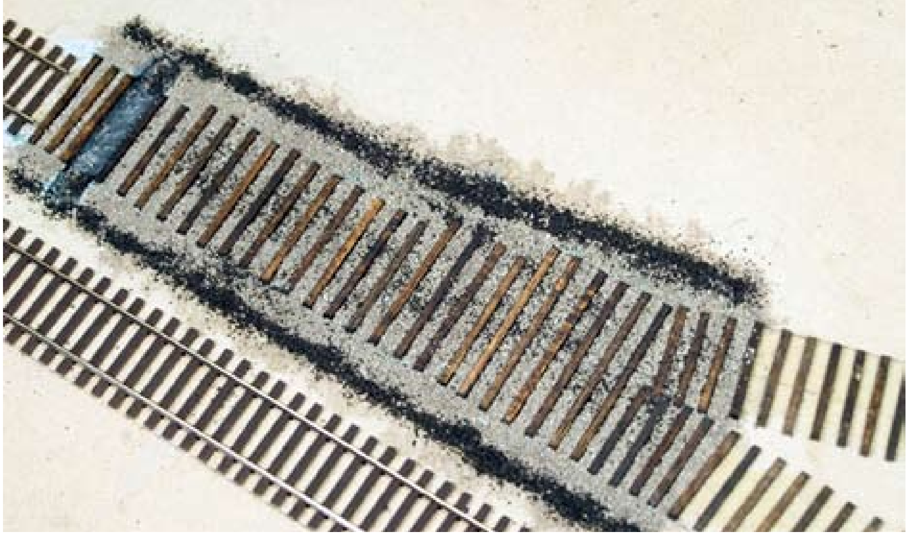


Fig. 13 Roadbed preparation. **Following the outline on the roadbed makes it easy for John to position the individual ties and then apply realistic ballast.**

Fig. 14 Rail installation. **After the glue dries, John positions the turnout on the ballasted ties and spikes it down before he removes the straps.**

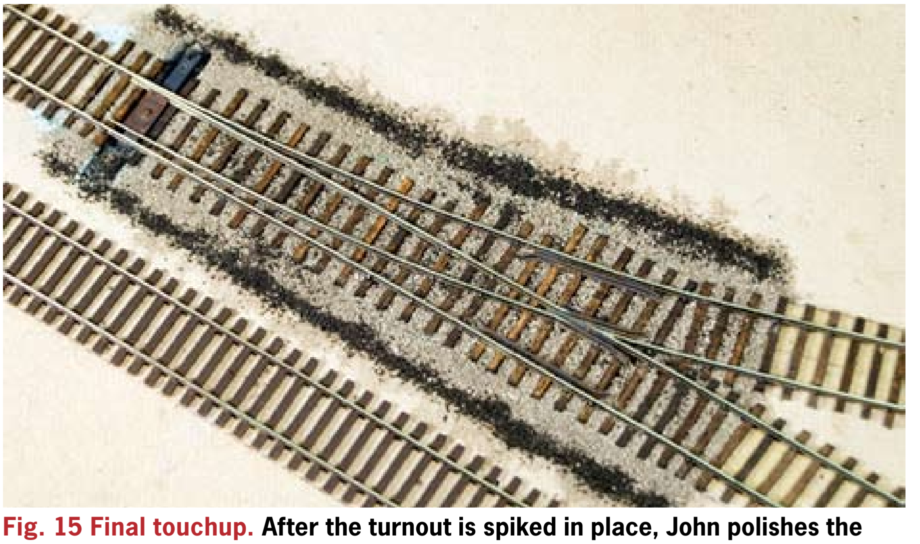


Fig. 15 Final touchup. **After the turnout is spiked in place, John polishes the rail heads and brush paints the frog's wing rails, guard rails, spacer plate, and switch rod with Grimy Black followed by a thin wash of Rust.**

From track plan to reality

Paul Dolkos explains how he translated his track plan for a new HO industrial railroad to reality, working on one area at a time. He started here at Curtis Junction on the Baltimore waterfront, where Baltimore & Ohio and Western Maryland lines enter the layout from staging tracks beyond the backdrop at the upper right.

The design is only the starting point

By Paul J. Dolkos
Photos by the author

So you have a dream track plan that you've fretted over and revised and revised. Friends have offered a variety of suggestions. Now – big drum roll – you're set to start laying track. But be prepared: You may quickly find that translating the two-dimensional plan into a 3-D model railroad requires a lot of deviations and adjustments.

Some people can visualize track arrangements and scenes on a paper plan and have them work out according to the drawings. But for most of us, it's difficult to think of everything. Some physical features of the layout space aren't quite what we thought they were, and so on. As we cut wood and lay out the right-of-way, we need to continually review how the track alignment fits into the overall space.

If you do, you'll find that track plan modifications are probably necessary or at least desirable. Such changes are always a part of the construction process, whether for a new building, bridge, or model railroad. (See "Don't rationalize, do it right" on page 54.) Even if you have to tear out some new construction, it's better to begin anew than to live with layout problems for years to come. Often you'll spend more time thinking about whether or not to change something than it will take you to actually make the change. This is the process I'm going through as I work on my new layout, a switching railroad set on Baltimore's industrial waterfront.

Laying out Curtis Junction

The first area I tackled, Curtis Junction and the related interchange and industrial tracks, was rather complex. As the partial track plan on the opposite page shows, three routes emerge from staging beneath an overpass that disguises an opening in the backdrop. The configuration looked okay on the scale drawing, but I wondered if it would really fit and not look crowded, cramped, or ridiculous in the actual space.

I started by making rough mock-ups of the track arrangements on a

Fig. 1 Roughing in. Where the tracks entered the room on Paul's layout, he laid a large piece of corrugated cardboard over existing benchwork to draw a rough mock-up of the track at Curtis Junction. Among other things, he learned that a ready-made 45-degree crossing would work in place of the handlaid crossing he'd anticipated.

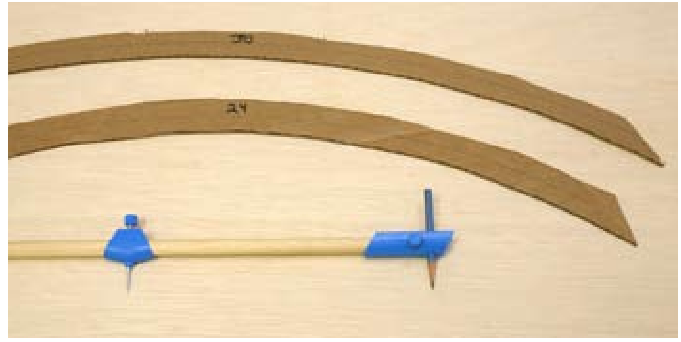


Fig. 2. Curve templates. Paul cut out cardboard patterns in various radii to help keep his mock-ups accurate. Trammel points (the blue gadgets) make it easy to draw templates for whatever curve radii your track plan requires. These came from Sears and fit onto a wooden dowel. The center point (left) adjusts to any radius.

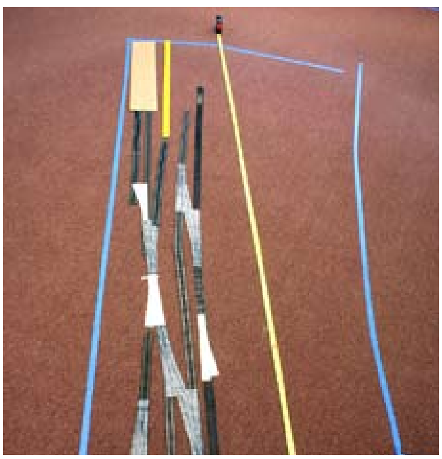


Fig. 3. On the floor. You can see how a proposed layout plan will fit by taping the benchwork outline on the floor. Here Paul used blue tape for the layout outline and laid out flextrack and photocopies of turnouts to try out the track arrangement. The long yellow line is a tape measure.

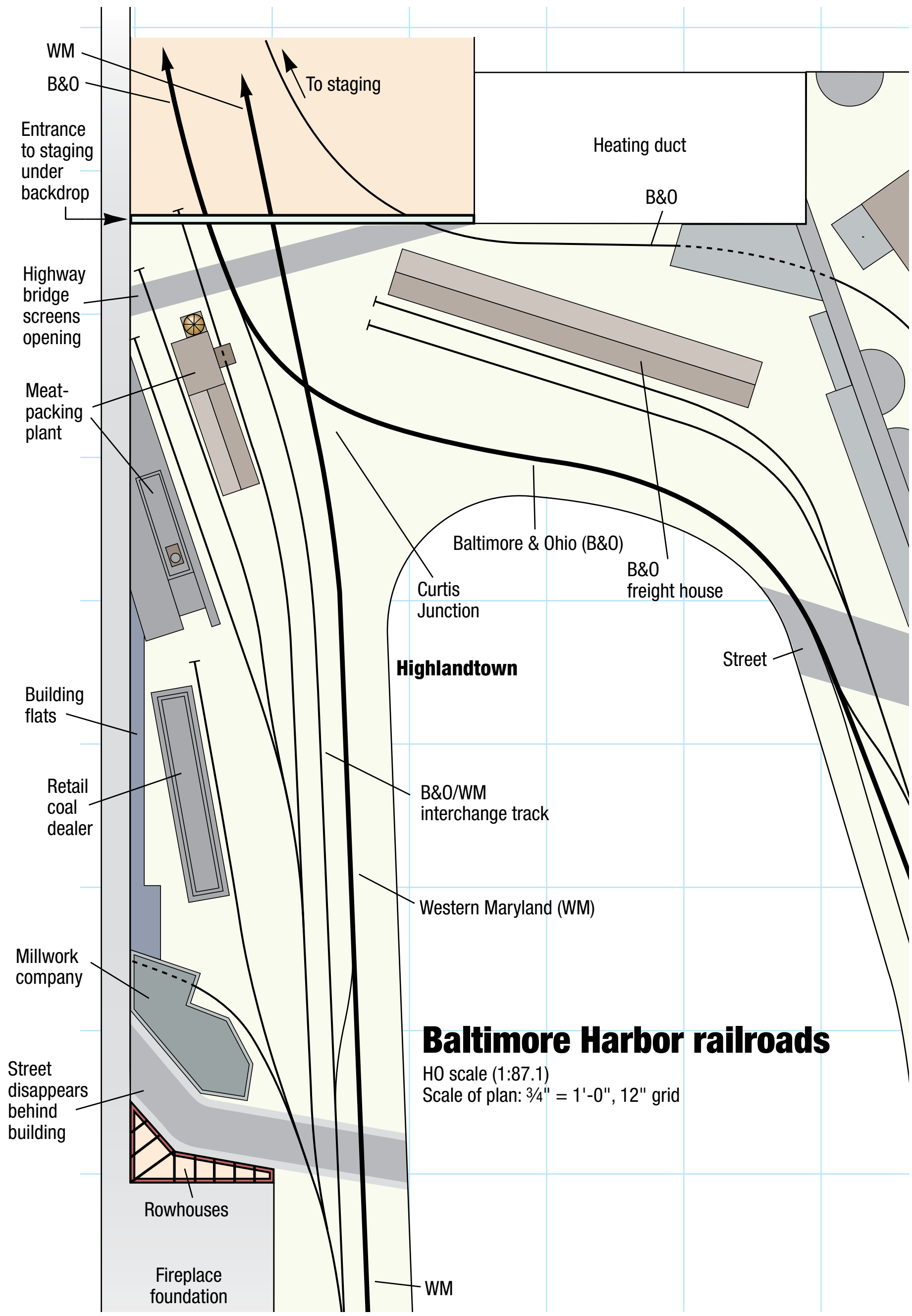


Illustration by Jay Smith

large sheet of cardboard laid over some basic benchwork left in place from my previous layout, as you can see in **fig. 1**. Beginning with lengths of flextrack tacked in place, I refined the mock-up as I saw how the tracks would fit together. To help me lay out curves, I cut out the cardboard curve templates shown in **fig. 2.**

With this full-size version of my layout plan, I both verified that the track arrangement I envisioned would fit and found ways to improve it. I quickly saw, for example, that where I'd thought I'd have to build a 55-degree crossing on a curve, a standard 45-degree diamond worked fine.

For other parts of the railroad, I wanted to confirm that my proposed track arrangements would fit before I got too far along. There I taped the

Don't rationalize problems, do it right!

Highways, buildings, and spacecraft are built using detailed plans. Nevertheless, changes are inevitable, and engineers have a formal process for incorporating them. While model railroaders don't need to be formal about it, we need to be open to making changes as we build a layout. Here are some issues to think about as you build.

• Will the track arrangement permit the operations you envision? Are the passing tracks or switching leads long enough for the trains you plan to run?

• Can the curve radii and clearances desired be achieved? If so, does the track arrangement flow smoothly, without awkward kinks and bends? It's possible to snake model track through virtually any labyrinth, but does it look right?

• Is there adequate room to develop adjacent structures or scenery, whether it be an industry or space for wayside signals, pole line, or a line of trees between the track and the backdrop? Think not just of laying a line of track, but in terms of the entire railroad right-of-way and the adjoining trackside real estate.

• Will you be able to easily reach all of the track for uncoupling, rerailing equipment, or cleaning and occasional repairs? – *P.J.D.*

proposed benchwork outline on the floor as in **fig. 3**, page 53, and used photocopied turnout templates and track sections to rough in some of the more complex track layouts.

Sure enough, I found areas where I had to make adjustments. I also made changes to maintain an aisle width of at least three feet. With this relatively simple exercise I confirmed the overall validity of my plan.

Layout plans drawn with computer software should be more precisely scaled than those done in pencil. However, you can still make mistakes by inserting the wrong template or specifying an incorrect curve radius. Nothing is perfect.

The computer-generated plan can be printed out full size and laid out on the floor or over the benchwork. Veteran model railroader Allen McClelland used printouts that way to build his last HO scale Virginian & Ohio (see the January 2009 *Model Railroader*). Allen said this was "an ideal way to visualize track arrangements, but I still made adjustments."

Trying it out with roadbed

Once you're satisfied with the proposed track arrangement, you're ready to install the subgrade or "baseboard" and roadbed. Where there are multiple tracks, a large sheet of plywood or extruded-foam insulation board, or a hollow-core door, usually makes a good baseboard. Tracks can be fastened directly to the

Trackwork choices

With an ever-increasing range of finely detailed track products, modelers today often ask each other, "What kind of track do you use?" On my previous layouts, much of the track was handlaid so I could use a variety of smaller rail sizes (codes) as appropriate. Now flextrack comes in several rail codes, and with detailing that's hard to replicate on handlaid track.

On my new HO scale layout I'm using Micro Engineering code 55 and 70 and Atlas code 83 flextrack. The Micro Engineering track offers the smaller rail sizes I want, but the Atlas track sections are more flexible. That makes it easier to lay curves and easements.

Varieties of track. This view at Highlandtown shows how Paul combines Atlas code 83 flextrack with Micro Engineering turnouts and code 70 flextrack.

Turnouts pose more of a problem than plain track, especially if you want smaller rail on much of your secondary track, as I do. Only a limited selection of turnout sizes are available ready-to-use with code 70 and smaller rail.

On my new layout I'm using a variety of approaches depending on the situation, as in the **photo below left**. Where I want to limit the length required, as at a crossover, I use Micro Engineering no. 6s, which are relatively short for their frog angle. [The point-to-frog distance, or "lead," is shorter in scale feet on the Micro Engineering turnouts than on many prototype no. 6 turnouts. – *Ed.*]

Wanting to use code 55 rail on sidings, I use Details West code 55 turnout frogs cast in white bronze and handlay the rails. It's not really difficult to build turnouts from scratch, and doing it yourself gives you the confidence to correct problems with any kind of track. Building even a few turnouts for your layout can open up options for track arrangements that would be impossible with standard turnouts.

The most useful custom turnouts are those built on curves. They can permit longer yard tracks and passing sidings, and the flow of curved turnouts through a yard lead can be extremely attractive. On curves I scratchbuild turnouts to fit the location. The **photo opposite** at Curtis Junction shows a turnout being built to fit the curve.

Help with turnouts. Over the years *Model Railroader* has published a multitude of articles on building turnouts. [There's another one on page 46 of this special issue. – *Ed.*] Typically you need to file six sections of rail, tapering rail ends or removing the base. In my experience this work

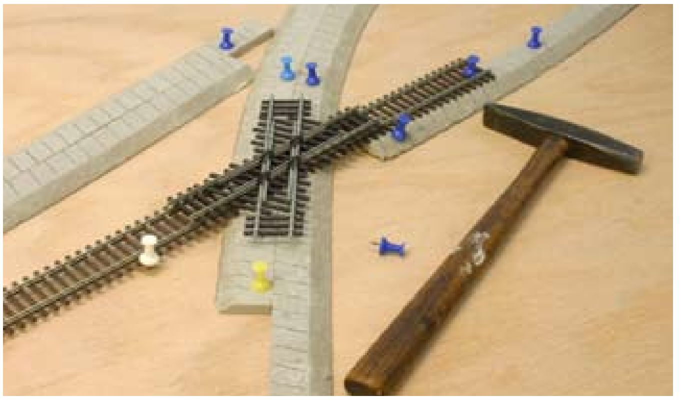


Fig. 4. Mock-up with roadbed. **Paul has pinned HomaBed sections in place with map tacks to further verify and establish the final track location. He also took the opportunity to test-fit a Walthers 45-degree crossing.**

Fig. 5. Check for obstructions. **Risers allow adjusting the level or grade of baseboards, but may interfere with turnout motors or other devices. Paul leaves all the screws exposed in his risers and joists so any of them can be moved.**

baseboard surface or elevated slightly on roadbed sections.

I use HomaBed from the California Roadbed Co. (www.homabed.com), roadbed milled from Homasote. It's made in paired strips with beveled edges like cork roadbed, but is a more solid foundation. I pinned it in place following my mock-up drawings on cardboard, as you can see in **fig. 4**.

Having the roadbed temporarily in place gave me one last chance to review the track arrangement and alignment. It's especially important to check turnout locations at this stage.

If you plan to use switch motors or other turnout mechanisms under the track, see if any benchwork elements such as those in **fig. 5** are in the way before you settle the track location. You may want to move an obstructed turnout, and an inch or two may be all that's necessary. Or you can move the obstruction. I build my benchwork so risers and joists can be unscrewed and moved if necessary.

When it all looked right, I ran a marker along the roadbed edges to save the locations, unpinned the HomaBed, then applied a thin layer of adhesive and put the roadbed back down.

Early testing

With the roadbed in place I was ready to lay track. This is a point that inspires most of us to get something running quickly. However, you might do well to think through some of the options you have for building track.

doesn't have to be precise; the critical part is setting the gauge of the turnout rails.

There are also products that can ease construction and assembly. For instance, Central Valley (www.cvmw.com) offers detailed molded plastic tie strips that accurately gauge the rails. Fast Tracks (www.handlaidtrack.com) makes a variety of track-laying items including jigs for filing points, frogs, and overall assembly. Earlier I mentioned Detail West's (www.detailswest.com) cast frogs. Micro Engineering also offers a cast no. 6 frog.

Height transitions. Where different track products and rail sizes meet, you have to match the varying rail heights with a shim or two under the lower-profile track section. To transition from code 83 to 70, for instance, use a shim roughly matching the difference in rail height (.083" - .070" = .013").

Height differences also arise with different tie thicknesses. The ties under Atlas code 83 track are approximately .020" thicker than Micro Engineering's. You may also find rails of the same code that don't match perfectly because they were made with different dies. These and other minor differences can be corrected with careful filing to level a joint.

Glue it down. Using adhesive caulk to fasten both the roadbed and the track on the roadbed is quick, clean, and easy. In the **left photo** on the next page I'm using caulk to glue Atlas track to HomaBed roadbed.

Two adhesive caulks that have worked for me are DAP's clear Kwick Seal Plus Kitchen & Bath Adhesive Caulk and Polyseamseal Clear All-Purpose Adhesive Caulk made by Henkel Consumer Adhesives. Clear caulk comes out white but dries transparent. For track I prefer that to caulk that dries white.

Each of these adhesives will immediately hold the roadbed or track in place, even when curved. You shouldn't need weights or pins. And while the adhesive grabs immediately, it stays loose enough to allow adjustments for a few minutes.

These adhesives come in either cartridges or squeeze tubes. For the relatively small amount of gluing was doing I found the tubes easier to use, but not as economical.

A thin layer of adhesive is enough. Apply a 1⁄8" bead and use a putty knife or artist's spatula to spread it as thin as you can. The caulk shouldn't ooze up between the ties when track is placed on it, and not just for neatness. If you want to remove the

Curved to fit. **To build a curved turnout for Curtis Junction, Paul used the HomaBed roadbed as a guide to draw the turnout plan on a block of wood. Then he took the block to his workbench to build the frog to fit the curve. You can see the finished turnout in the large photo on top of page 52.**

Fig. 6. Early testing. **In the left photo, most of the trackwork is installed at Highlandtown and Curtis Junction. Paul wired it, including the turnout controls on the white panels, and then ran trains to test the new track, as in the right photo.**

For my advice on this, see "Trackwork choices" on page 54.

It's useful and fun to run some trains to test your trackwork as you build. As each section of the railroad is complete, such as the area shown in **fig. 6**, wire it either temporarily or permanently. Then try out the track to be sure it's okay. It's easier to find and fix faults in a small area than to debug a whole railroad at once.

Do your test running with a locomotive that's unforgiving of bad track. A steam engine with leading and trailing trucks will find more problems than a diesel switcher.

Stay flexible

Even after you've carefully adjusted a track alignment, and are satisfied with its operation, you may still find something you'll want to change. You may have allowed what seemed to be enough room for a structure or other element, but it's not working out. Rather than stewing over it, I've found that it's easier to move track, especially a siding, than to modify a structure or tailor scenery to fit.

Getting track right, both visually and operationally, is important to our long-term enjoyment of any layout. Take the time to be sure you'll enjoy your railroad. RRT

Paul Dolkos's new layout design will be featured in Model Railroad Planning 2010, *coming in January. Order it now at www.ModelRailroader.com.*

Trackwork choices (cont'd)

roadbed or track, sliding a putty knife underneath will easily break a thin adhesive joint. You should be able to reuse the track, and perhaps the roadbed too, depending on its material.

It looks better painted. With various track components having combinations of plastic and metal parts, perhaps some wood ties, and solder joints for feeder connections, the completed track can look a bit shabby, as in the **center photo** below. It may be a long time before you get around to adding ballast, but spraying the track with a light coat of a color like Polly Scale Roof Brown blends all the different colors and materials together. This significantly improves the track's appearance, as you can see in the **right photo**. Just remember to wipe the railheads clean right after spraying, before the paint has time to harden – *P.J.D.*

Gluing track. **Here Paul has applied a thin coat of adhesive caulk to the HomaBed roadbed to hold the flextrack in place. Clear adhesive caulk is white when applied, but it will dry clear. The caulk has enough tack to grab the track immediately, so it doesn't have to be pinned in place, but adjustments will still be possible for a few minutes.**

Mis-matched look. **Paul was happy to discover he could use a code 83 45-degree crossing from Walthers at Curtis Junction, and he dressed it up with Grandt Line bolted joint bars. But overall the track here has a mis-matched look thanks to wood ties on the approach tracks at the top and right, shims for adjusting track heights at the crossing, and soldered feeder wires.**

Blended with paint. **By spraying the track with a light coat of Polly Scale Roof Brown, Paul blended all the varying tie colors, colored the rail webs and solder joints, and gave the trackwork a more uniform, finished look. After cleaning the rail he repainted the tops of the guardrails Roof Brown, and used silver paint on the railheads to disguise the crossing's black plastic insulation.**

Track gang tips

Cork roadbed shaping fixture

A simple tool for a simple task

Separating the two halves of cork roadbed strips leaves unrealistic sharp and jagged corners at the top of the beveled sides. Not just unsightly during construction, these rough corners can make it difficult to ballast the track realistically later on. Ragged cork poking through can spoil the look of your ballast shoulder. A simple fixture for holding a half strip of cork roadbed makes it easier to round the top edges of the roadbed.

The photo shows how the fixture conveniently holds the roadbed half straight while I round the top edge with a 60-grit sanding block. A few quick strokes along the top edge of the roadbed create a nicely rounded profile. No great skill is needed to get consistent results. The sanding creates dust and debris, so I do the work outside on a porch railing.

This simple fixture holds a strip of cork roadbed so the jagged corner can be sanded. Bob Kingsnorth photo

I made the fixture from a 3-foot length of 1 x 3 lumber and a 1/8" x 3/4" strip nailed about 7/8" from the edge. (The 7/8" dimension is for HO cork roadbed; adjust it to suit roadbed for other scales.) A strip of screen bead molding from a home-improvement store or lumberyard is roughly 1/4" x 3/4" and works nicely.

The fixture helps by holding the flexible cork strip straight while I run the sanding block along the top edge. – *Bob Kingsnorth*

The old yardstick trammel

How to make a common tool more versatile

A binder clip instead of a hole drilled in the yardstick makes this oft-used tool more versatile. The left edge of the clip is set at the desired radius, and the clip handle guides the pencil point. Bob Kingsnorth photos

The radius center is near the zero end of the yardstick, but the exact position will depend upon width of the particular binder clip that you use. The left edge of the hole shown is equivalent to zero for the pencil location in the handle of the binder clip.

Here's a new variation on using a wood yardstick as a trammel to lay out curves. Instead of drilling holes in the yardstick, I clamp a small binder clip to the side. In the **left photo**, I'm drawing a 33 1/8" radius. The left edge of the clip is set at the desired radius, and the clip handle guides the pencil.

The binder clip can be moved to any mark on the yardstick's scale to draw whatever radius you need. A small hole drilled near the zero end of the yardstick will serve as the center of the curve.

To start I set the clip at my most common radius, with the inside edge at that mark. Let's use 32" for example. Then I measured from the pencil location in the clip handle 32" back toward the zero end of the yardstick. For the particular clip I used, the mark was at 9/16", as in the **right photo**.

I drilled a 1/8" hole in the yardstick, putting the hole on the plus side of the mark. In fact, I allowed an additional 1/16" on the plus side when drilling, re-measured, and then used the drill to incrementally elongate the hole to exactly the 9/16" mark, so the radius drawn at the clip would be exact.

This way, the mark where the inside edge of the binder clip is set on the yardstick's scale accurately represents the radius where the pencil is held in the clip handle.

In addition to a centerline radius, I draw the outer edges of the roadbed, plus 1/8". The moveable binder clip is a fast and easy way to lay out these odd radii. The clip can't handle a lot of strain in swinging curves, but it works well in normal use. – *Bob Kingsnorth*

Applying civil engineering practices, Neal Schorr has modeled a right-of-way that depicts the Pennsylvania RR's former Middle Division as it was operated by Conrail in the 1980s.

Right-of-way realism through civil engineering

Prototypical construction practices help shape an authentic main line

By Neal A. Schorr/Photos by the author

We've all seen how ballasted track contributes to the realistic appearance of a model railroad. Although many layout builders will add details to their model railroad track, they'll often neglect to factor civil engineering practices into the design and construction of the right-of-way.

I have an interest in civil engineering, so I'm passionate about reproducing the Pennsylvania RR's Middle Division physical plant on my O scale, three-rail layout. Following are some of the civil engineering practices that I've incorporated on my layout – many of these you can easily apply to improve the construction and authenticity of your railroad right-of-way.

Civil engineering considerations

Applying the following civil engineering principles will help you construct an accurate model railroad right-of-way:

• Track geometry should use the broadest curves possible, tightest track centers (the distance between the center of two adjacent tracks), and the lowest grades possible.

• The right-of-way typically consists of alternating cuts and fills that maintain moderately pitched slopes.

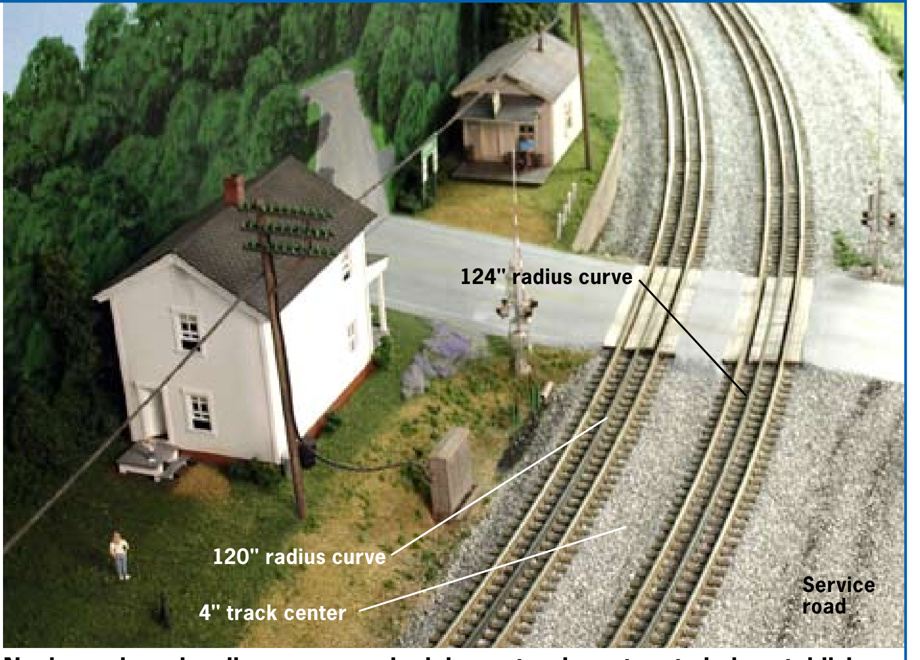
• Provisions for drainage along both sides of the track, as well as a culvert at the base of every fill, are essential.

• Include a path for a pole line, the route that the trackside utility poles follow.

Track geometry

Track geometry, the position, curvature, and alignment of the rails, is likely the single most significant factor in establishing the realism of a model railroad right-of-way. Although the typical minimum radius on my O scale layout is 60", I included a few curves of very large radius. Broad-radius curves can effectively limit the overhang of long equipment such as 89-foot flatcars. On tangent (straight) tracks, the track centers (distance between the tracks) can be minimized for more prototypical appearance.

Also note the service road to the right of the tracks. While common on the prototype today, they are seldom modeled. The Middle Division was originally four tracks wide in most locations. As traffic declined after World War II, PRR removed one of the tracks in the 1950s. In the 1980s, Conrail removed an additional track, which provided room for a maintenance road.



Neal uses broad-radius curves and minimum track centers to help establish a right-of-way with a realistic appearance.

Typical terrain

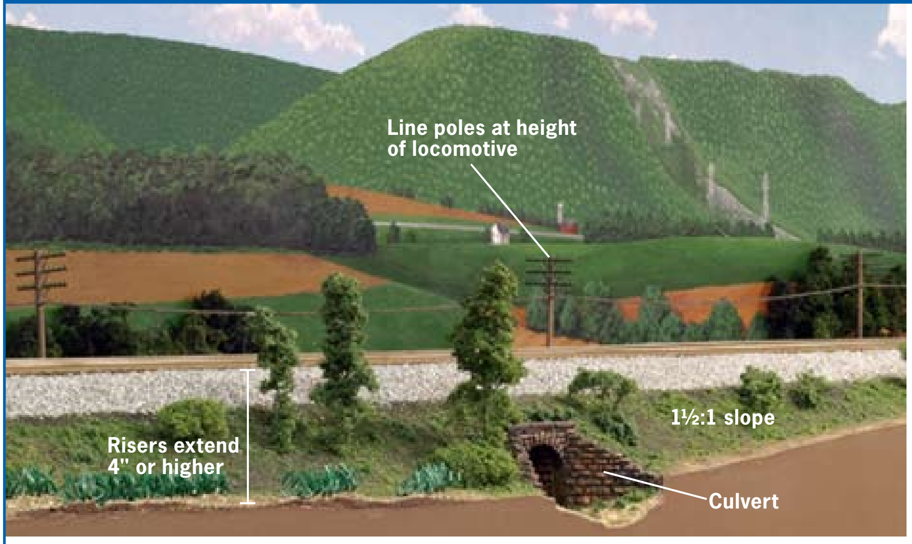
A few key components are identified in this typical right-of-way scene on Neal's PRR Middle Division layout.

Model railroaders love to create the spectacular, but it's the inclusion of the ordinary that lends credibility to a scene. In a scene typical of the Pennsylvania RR's Middle Division, a stretch of track cuts through the woods at the base of an Appalachian mountain ridge.

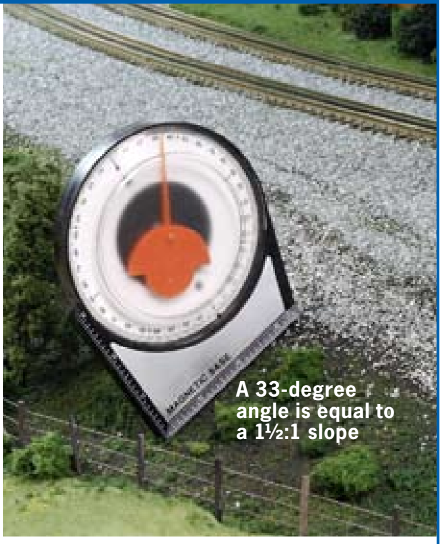
Other common scenes on the prototype include broad farm valleys set between towering ridges, with the right-of-way tucked between the bottom of a ridge and a waterway.

An adjacent pole line shows that trackside utility poles, properly known as line poles, are typically mounted at the top of cuts. The right-of-way for the pole line is generally kept clear of all but scrubby vegetation. In the foreground, you'll also notice a service road with deep ruts exposing cinders remaining from the steam era.

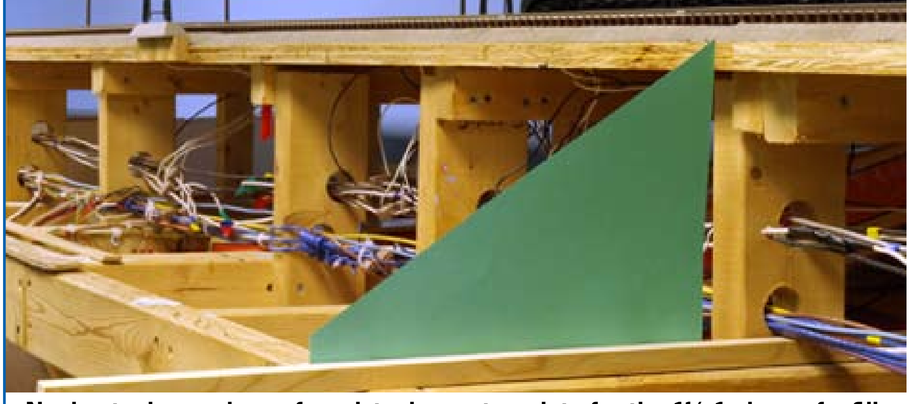
Fills



The fill built along this long stretch of right-of-way raises the track more than 4" above the layout benchwork. The culvert is directly above the benchwork.

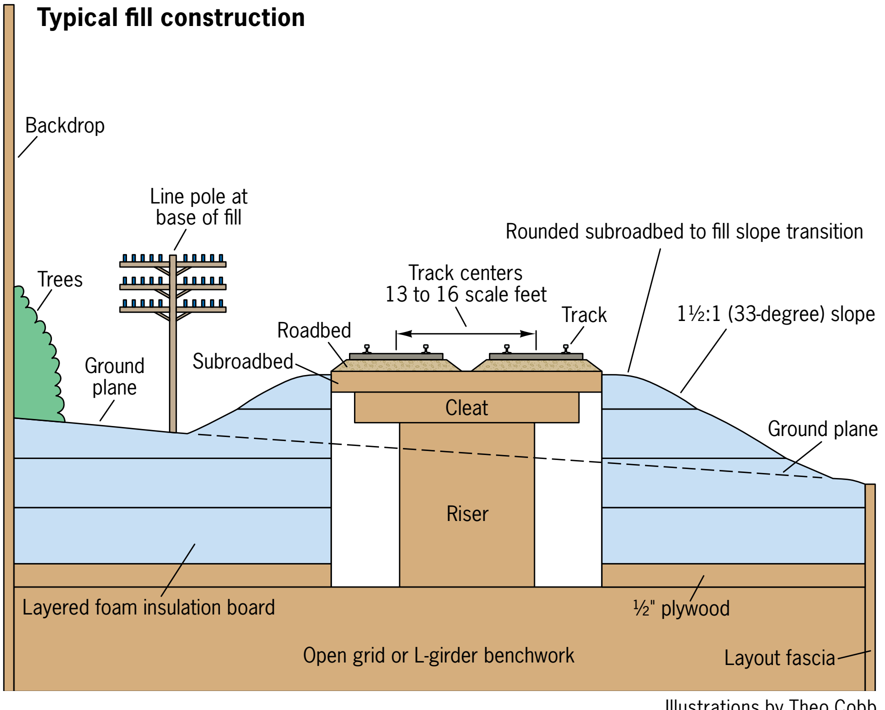


A Micro-Mark angle gauge indicates the angle of the fill slope.



Neal cut a large piece of cardstock as a template for the 1½:1 slope of a fill.

Typical fill construction



Illustrations by Theo Cobb

Fills, built-up formations of earth or rock, are the most underrepresented terrain feature on model railroads. To accurately reflect most prototype routes, about half the right-of-way on your layout should be built on fill. At the **upper left**, a long, low fill carries the Middle Division across one of the broad farm valleys common to central Pennsylvania.

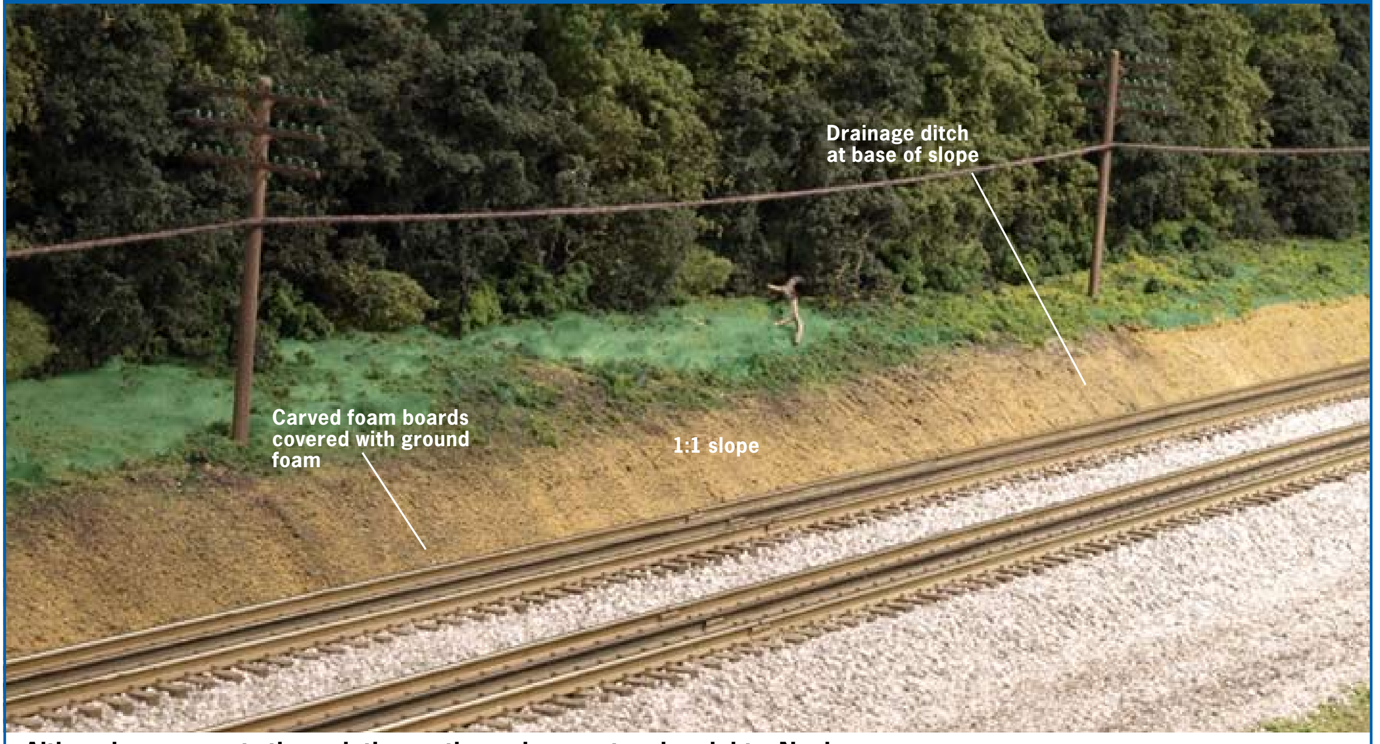
I model fills by first building the subroadbed on risers 4" or higher above the benchwork, as shown **at left**. Next, I stack and glue layers of foam insulation board to the top of the benchwork on both sides of the subroadbed. I use a hot wire tool to carve the foam to a rough slope. Next I use a rasp or Surform tool to refine the shape of the fill.

In a credible fill the slopes should be no steeper than 1½:1. For every inch and a half of fill slope width, the height of the fill should equal one inch. Additionally, the fill should descend to the level of the native earth at the rear of the right-of-way as in the **illustration at left**. When refining the slope, I gently round the top of the fill into the top edge of the subroadbed. This shoulder will serve as a transition between the base of the ballast and the top of the fill.

At the bottom of each fill I install a culvert or pipe. These are essential civil engineering details that I install as evidence of proper drainage. Railroads use these to let water flow underneath the tracks, preventing a fill from functioning as a dam.

Finally, I add line poles at the base of the fill, with the crossarms at the same height as a typical locomotive operating along the rails.

Cuts



Although severe cuts through the earth can be spectacular sights, Neal uses a shallow slope to make his right-of-way look more authentic.

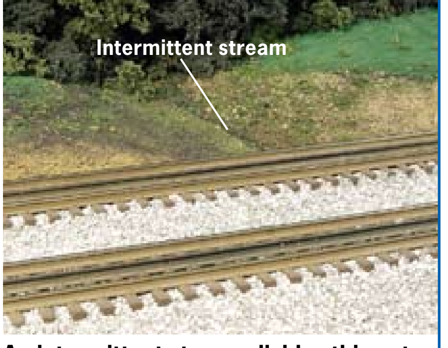
Cuts in the earth are more frequently modeled than fills. As in representing a fill, it's important to follow sound engineering practices to model a plausible cut.

A cut can be quite deep, and its slope can be practically vertical when the right-of-way passes through solid rock. This may look spectacular, but it's far more convincing when a cut is relatively shallow and passes through softer material, as in the **top photo**. In such instances, the slope of the cut is far less severe. Although the exact angle (called the "angle of repose") varies with the material being cut, a slope of 1:1 (45 degrees) is generally acceptable for modeling purposes. See the **illustration at right**.

The face of the cut may be covered with vegetation or simply exposed soil. I've modeled these features by carving layered foam board and covering the area with a variety of earth-colored ground foam. To simulate signs of erosion, I spray a mist of water down the slope after adding ground foam, but before applying diluted white glue (1 part glue, 3 parts water) with an eyedropper.

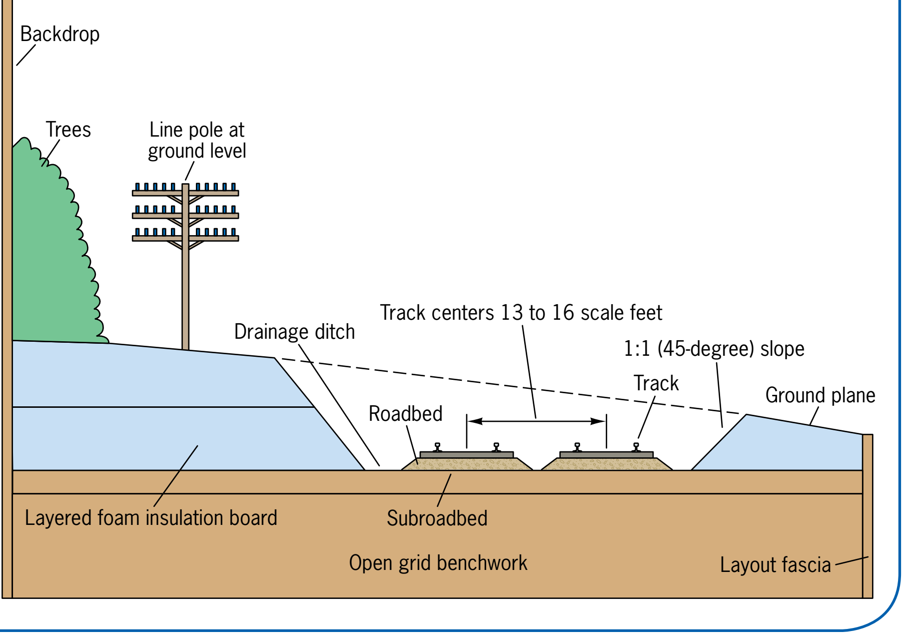
In the **smaller photo** you'll see a depression in the cut above the tracks. This is an intermittent stream that carries water only at times of heavy rainfall. I modeled this ephemeral waterway by pouring a narrow band of Woodland Scenics Realistic Water into the base of the depression.

As shown in the illustration, a drainage ditch between the bottom of the cut and edge of the ballast slope is an essential engineering detail.



An intermittent stream divides this cut.

Typical cut construction



Drainage ditches and culverts

Stone culverts, much like those modeled on Neal's layout, allow a stream to pass under fills. Culverts can also be constructed of wood or concrete.

Water drainage is essential in preserving the integrity of a railroad right-of-way. The trackside drainage ditches at the foot of each cut should run parallel to the tracks up to the start of a fill. From this location, water travels down to the base of the fill and merges into a streambed. To prevent the fill from functioning as a dam, the stream passes under the fill through a culvert.

Stone culverts are common east of the Mississippi and on the Pennsylvania RR were the norm. Culverts are easily modeled using commercial kits or you can scratchbuild your own from wood, styrene, or plaster.

To enhance the appearance of the culverts on my layout, I install a lining and route the streambed through the full width of the culvert. To accomplish this, I build the streambed on a piece of scrap plywood at my workbench and then install the completed unit on the layout. With the culvert in place atop the streambed, I can then carve foam board pieces and add them to form the fill.

Culverts can also be box structures constructed of wood or concrete, or simply metal or concrete pipes. Culvert construction varied between different railroads, and sometimes varied on different parts of the same road.

Ballast

Ballasting practices can vary based on many factors, including the type of track (mainline, branch, or yard) and the era modeled.

The top photo depicts typical mainline track maintained from the 1960s through present day. Before that, railroads often constructed the subgrade from cinders, a byproduct of steam locomotives.

In this arrangement, ballasted roadbed sits on top of the cinders. Initially railroads used inexpensive manual labor to shape the ballast with a defined edge that clearly distinguishes it from the underlying cinders. With railroads progressing to mechanized maintenance practices, the ballast is less manicured.

Along a more contemporary right-of-way, ballast is now likely to be strewn over the edge of fills and into the adjacent vegetation. But even today, years after the demise of steam locomotives, cinders are still visible.

The **lower photo** illustrates yard tracks typical of the steam-to-diesel transition period. Here, cinders are still the predominate ballast in the yard. Some newer rock ballast appears where maintenance crews may have filled low spots in the track, including areas near or under turnouts.

Along the perimeter and in random locations throughout the yard, I also added small tufts of green and yellow ground foam to respresent weeds growing in the cinders.

Grade crossings

The grade crossings are level, but the paved roads on Neal's layout approach from either above or below track level.

When modeling a grade crossing, it's important to consider civil engineering practices regarding drainage. To prevent water from draining onto the tracks, roads that intersect the railroad right-of-way typically approach from below track level.

In the **photo above**, the road levels off as it crosses the tracks, then descends as it moves toward the backdrop. You'll also see that the right-of-way is built on a fill. Note how the pole line rises from the base of the fill as it nears the grade crossing.

In the **photo at right**, the road is heading uphill but levels off where it intersects the tracks. Out of sight to the right, the road slopes down away from the crossing. Water would flow from an actual road embankment into the trackside drainage ditch.

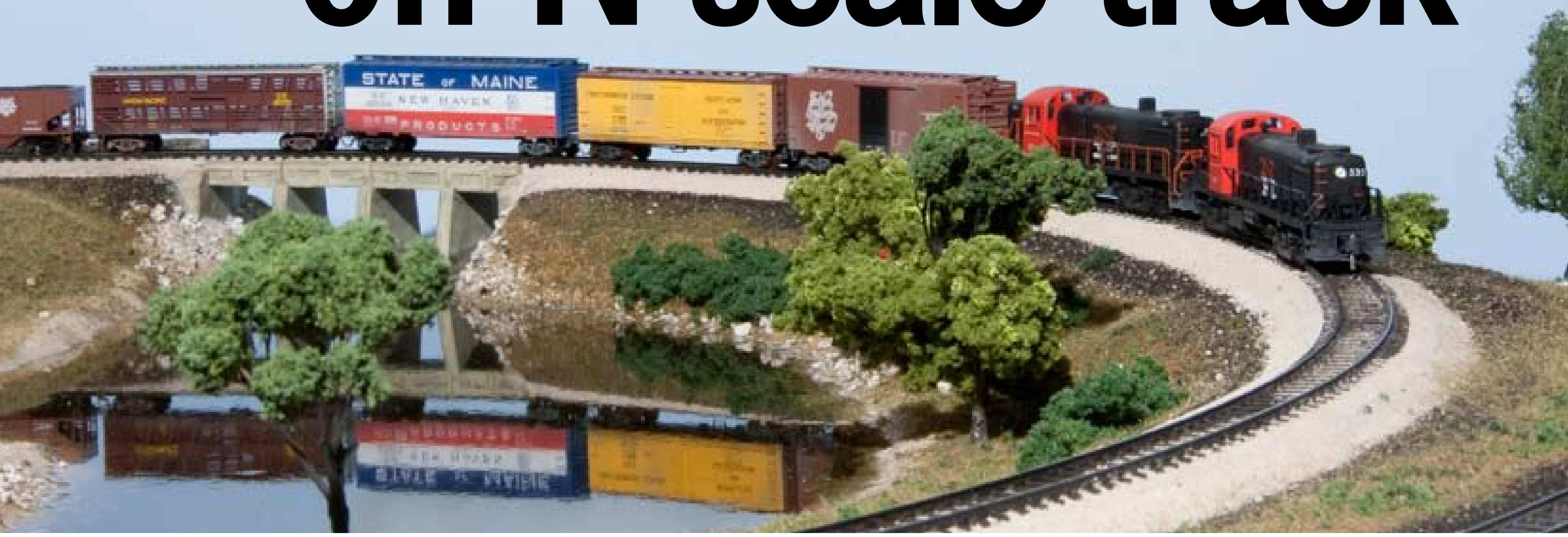
Other features include the relay cases detailed with a cable drop running from the line pole. Also, the house sits up above the railroad; its foundation has been recessed into the ground (a hole cut in the foam insulation board) rather than merely being placed at track level. And on one side of the grade crossing, I added a shallow cut with a 1:1 slope.

The **closeup photo** shows the corrugated pipe culvert I placed under the road. The growth of cattails here shows the pipe is obstructed. Though not desirable from the railroad's standpoint, this sort of engineering shortcoming is often seen on the prototype and is just one of many interesting details you can model along the right-of-way. RRT

Neal added cuts, drainage ditches, and other key civil engineering details that help make this grade crossing scene authentic.

Once an HO scale hobbyist, Neal Schorr is now an ardent O semi-scale modeler. His Pennsylvania RR Middle Division three-rail layout was last featured in the 2007 edition of Model Railroad Planning *magazine.*

Smooth running on N scale track



Model Railroader managing editor David Popp shares some of the track-laying tips he used when building the latest addition to his N scale Naugatuck Valley RR layout.

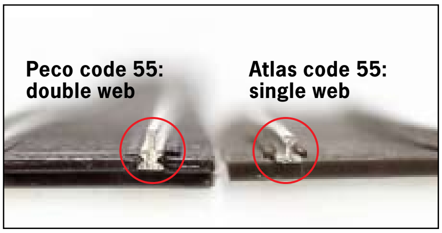
Following some key techniques to produce reliable N scale trackwork

By David Popp/Photos by Jim Forbes and the author

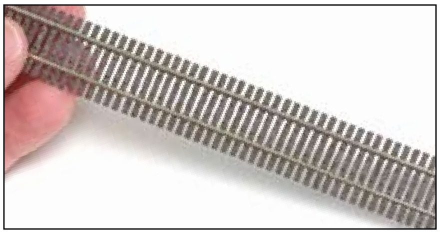
Laying N scale track that looks realistic and operates smoothly is easy if you know a few key techniques. Recently I added the town of Winsted, Conn., to my Naugatuck Valley RR, which of course meant that I had to lay more track. Though I'd already built an entire layout that operates well, this time I changed a few of my track-laying techniques for what I feel are better practices – it's never too late to learn something new.

When it comes to laying N scale track, my brand of choice is Peco code 55 flextrack and turnouts. Though other manufacturers offer track that has a more delicate and realistic appearance, there has always been one overriding factor to my choice – turnout control. In N scale all manual ground throws appear oversized, and the close spacing of turnouts in yard ladders can make it difficult to fit under-layout turnout motors. Peco turnouts, however, come with a toggle spring built into the switch points. Simply nudge the points with your finger to align the turnout, and the points stay in place.

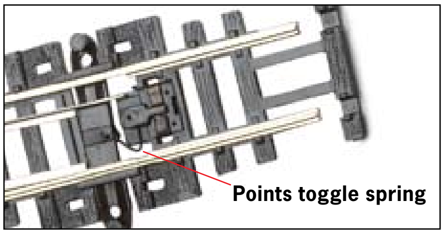
With that said, here are some of my favorite tips for laying N scale track. The techniques shown here can be used with almost any brand of track, as well as in other scales. And with a little practice, I'm sure you'll be pleased with your results.



Here is a comparison of Peco and Atlas code 55 flextrack. Though both have the same rail height above the ties (.055"), the Peco track is made with a second web and base. These are hidden in the molded plastic ties and make the track sturdy.



You can mix and match brands for track easily. Here is a section of Micro Engineering bridge track, which has ties that are both wider and more closely spaced than regular track. I use this track on the various bridges on my layout, and it works well.



Peco turnouts have a toggle spring built into the switch points, eliminating the need for a turnout motor or manual ground throw. The spring allows an operator to align the turnout by gently nudging the points with a pencil, uncoupling pick, or finger.

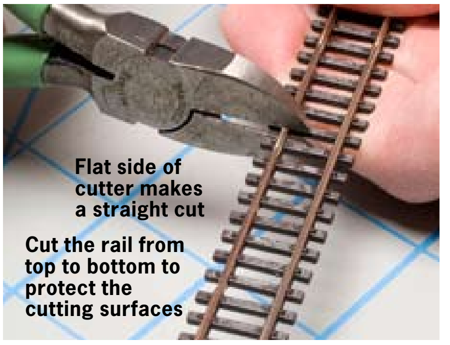
Cutting and joining track sections

When I lay track, I work methodically, cutting and fitting components in one area before moving on to the next.

I discovered a few years ago is that it really does matter which rail joiners you use. On this project, I found that my local hobby shop stocked Peco rail joiners, so I bought them instead of my usual brand – and guess what? The Peco joiners worked perfectly, making the job go much faster.

Along the way, I also upgraded my tools. I retired my old battered rail cutter for a new one, which meant I spent far less time cleaning up cut rail ends with a file. And, I traded my .062"-diameter rosin-core solder for .032". The smaller solder makes for more accurate control when soldering rail sections together or attaching feeders.

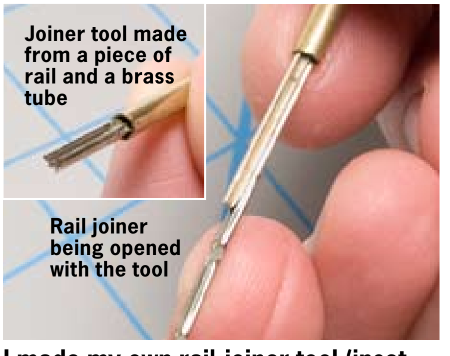
Often it's the little things that can make for an enjoyable track-laying experience.



To cut track sections to length, I use a flush cutter made for cutting metal. Be sure that the flush side of the cutter faces the section on track you want to keep. The cutter crushes the rail on the opposite side. Also, you can make sure your cutter stays sharp for years to come if you consistently cut the rail across the top and bottom parts and not from the side.

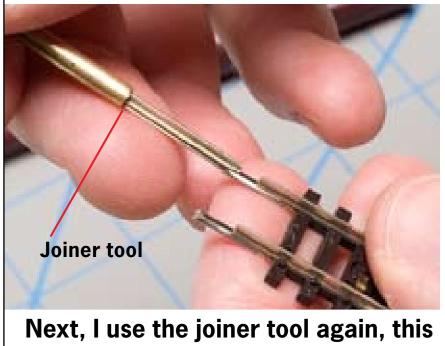
The next step is to make room for the rail joiners at the ends of the section of track. To start, I cut away the last tie and its adjoining web spacer on both pieces of track. Save the plastic ties, as you'll want to put them back later in the replacement tie step. I usually keep a small plastic cup near my work site to hold the loose ties.

Even rail cut with the sharpest cutters will still need a little dressing. I use a triangular jeweler's file to clean up the cut, making sure that the rail webs are clear of metal. This way the rail joiners will slip onto the rails easily, speeding up the overall project.



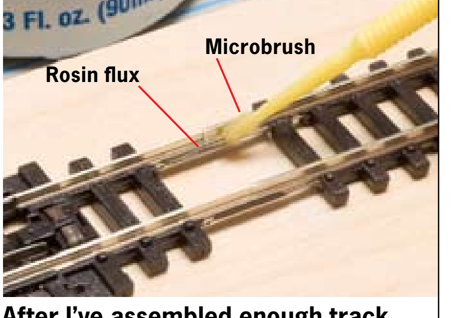
I made my own rail-joiner tool (inset photo), following a design I saw in MR years ago. The tool is essentially a piece of rail soldered into a brass tube. The rail end is filed to a point, making it easy to slip into rail joiners to open them, so that the joiners will then easily slip onto the rails.

Once I've opened one end of a rail joiner (they come in strips of four), I slip it onto a section of track, using the remaining joiners in the strip as a handle. I clip the joiner from the strip, using my flush cutter, and then I use the joiner tool to open the next rail joiner, repeating the process.



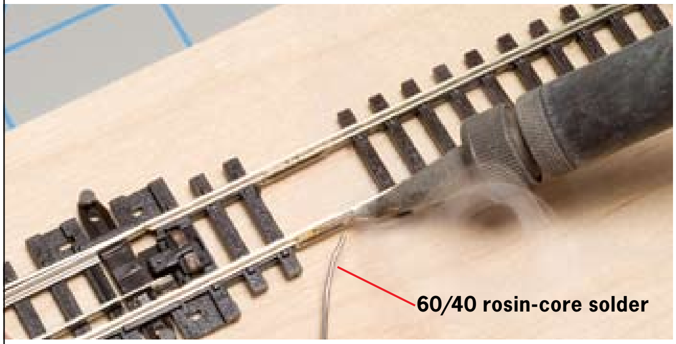
Next, I use the joiner tool again, this time to open the opposite ends of the joiners. I then set both sections of track on a flat surface and slide them together. I check that the rails are seated properly by running my finger over the tops of the rails.

Sometimes you need to insulate the rails. Lately, I've taken to using Peco's low-profile plastic rail joiners. These have a small nub in the center that creates an insulating gap between the rails. After the track is painted, the insulated joiners blend into the scene.

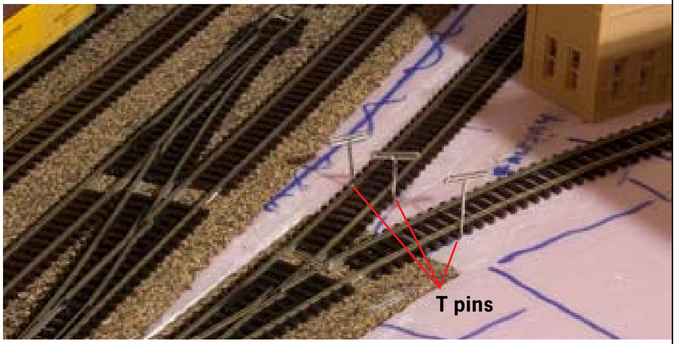


After I've assembled enough track for a small section of the layout, I solder the rail joints. To prepare the joints for soldering, I apply a small amount of rosin flux to them, which when heated, will burn off any impurities on the rail surface.

Cutting and joining track sections (cont'd)



When soldering N scale rail, I use an iron with a pencil point tip and make sure I lay it at the joint where the two rails meet to heat them and the joiner equally. I use the solder sparingly, just enough to flow down into the joiner. I remove any excess solder from the rail with a small file.



As shown in this photo, when working on a section of the layout, I'll cut and fit all the track for one area first, using T pins to hold track sections in place while I work. Once I'm satisfied with the fit, I'll then solder all the joints before moving on to the wiring phase.

Joining different types of rail

Because Peco's code 55 track uses double-web rail (see the bottom left photo on page 64), it needs some special preparation to be used with other brands of single-web track, such as Atlas or Micro Engineering. One approach is to slip a rail joiner onto the Peco rail and then position the joining single-web rail on top of the joiner and solder it in place.

For greater accuracy, as shown in the accompanying photos, I file away a 3⁄16" section of the lower base and web from the Peco code 55 rail. This creates a short section of single-web rail that can then be joined normally to any other brand of track.

To join Peco's double web-rail to other brands of single-web rail, I start by filing away the lower base and web of both rails at the end of a section of track. Filing away about a 3⁄16" from the end is enough to accommodate a standard rail joiner.

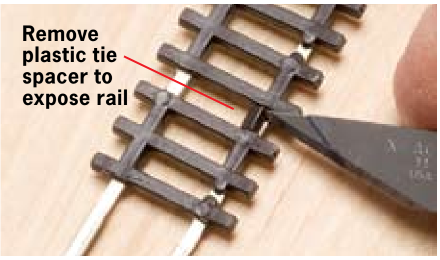
Once the Peco track's rails have been filed, I slip a rail joiner over the end and insert the connecting single-web rail section. I then solder the joint like any other section of track. You may need to shim the ties for a smooth transition.

Wiring

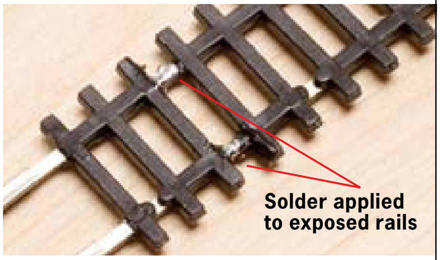
My favorite way to disguise feeder wires is to solder them to the underside of the rail. After I've soldered all the joints for a section on the layout, I move the track to my workbench for wiring.

I use 22AWG solid wire for my feeders because I have a large supply of it on hand. However, you may want to use stranded wire, as it's more flexible.

Sometimes I'll use a jumper wire to power a short length of track in place of a feeder. In this case, as shown in the photos, I solder a wire from one rail to another, eliminating the need for an additional connection to the track bus.

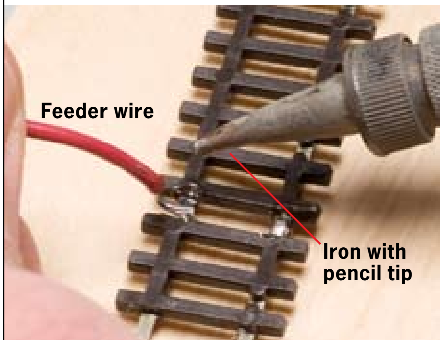


Wherever possible, I'll solder a feeder to the underside of a rail joiner. However, that's not always ideal. For this example, I start by cutting away a spacer in the plastic tie strip to expose the bottom of the rail.



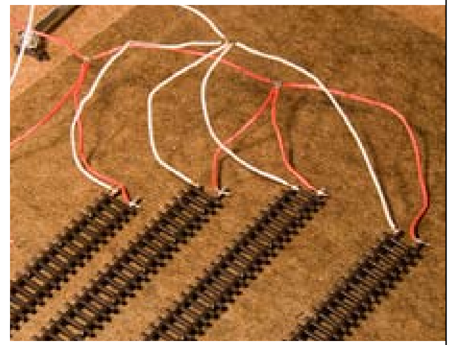
The next step is to tin the exposed rails where the feeders will connect. Tinning means that you apply solder to both pieces you wish to join, in this case the feeders and the bottoms of the rails.

Wiring (cont'd)

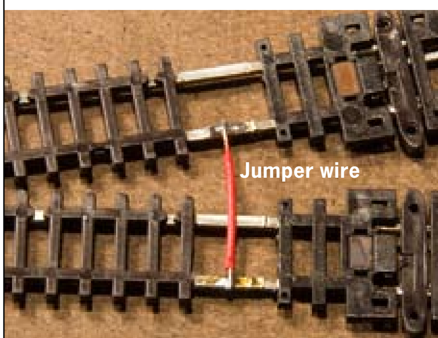


With the rails and feeders tinned, we can now join them. Simply hold the two pieces together and then quickly heat them with the iron. The solder should melt immediately, and no additional solder is necessary. As shown in the photo, I've just heated the feeders for the left rail.

An often overlooked step when soldering rail joints and feeders is cleaning up the work area. After you've finished all the soldering work, clean the solder joints with a toothbrush dipped in denatured alcohol. This removes flux residue, which is sticky and attracts dirt.



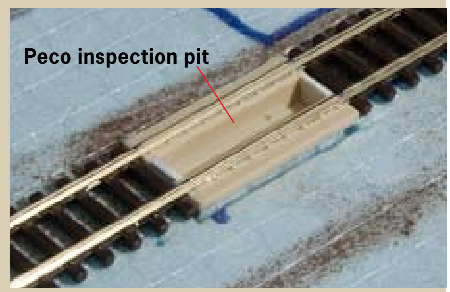
This is an example of feeder economics, making for neat wiring practices. On this stub-ended yard section, I soldered a small feeder to the underside of the end of each rail section and then joined all the feeders to one that will then connect to the track bus.



Sometimes it's easier to use a jumper than to run another feeder to the track bus. As shown here, I ran a jumper wire from a rail connected to the bus (bottom) to power a small section of rail that's isolated between two turnouts.

Easy unloading pits

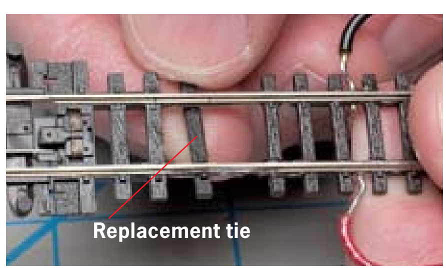
A neat detail offered by Peco is its no. 142566 N scale inspection pit. The pit comes in short sections that are cemented together to make any size inspection pit needed. The sections can also be adapted to make great unloading pits for coal, grain, cement, or sand. For this task, I typically use a single pit section and wall off the ends with styrene. A small bit of styrene tube cemented in the bottom makes a convincing auger.



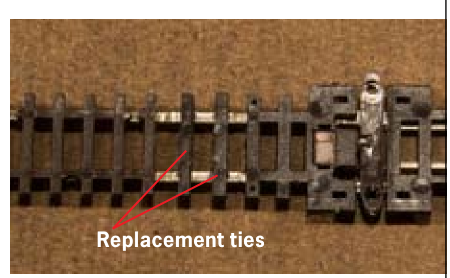
The plastic Peco pit sections easily snap onto the rails. The pit sits 1/4" below the level of the track, so I needed to cut a hole in the roadbed.

Replacement ties

While the track sections are on the workbench it's a good time to replace missing ties. Peco turnouts come with extra ties, but I needed more, so I made my own by using extra ties from scrap track sections.



For the replacement ties to fit properly, they need to be notched to accommodate the depth of Peco's double-web rail and the width of the rail joiners. As shown in the photo, I test fit each replacement tie before using.



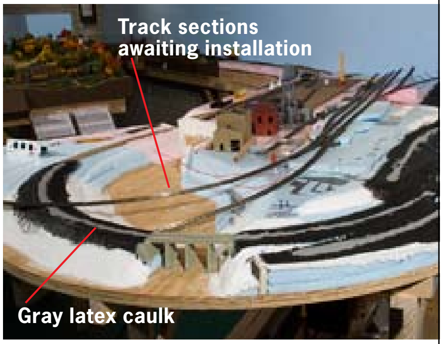
To keep the ties attached during the track-laying process, I cement them to the rails with cyanoacrylate adhesive (CA). Though it's a tedious job, adding replacement ties before laying the track is much easier.

Laying track

Finally, it's time to actually lay the track, right? Well, not quite. Before installing the track segments on the layout, there's still some roadbed preparation to be done.

My technique for installing roadbed is to lay N scale cork strips on top of a base of extruded foam insulation (see the opposite page for more details). Though cork roadbed is fairly smooth, sometimes there are variations (most often dips) in the surface of the foam. If I spot the dips before laying the cork, I'll fill them with spackling compound and then lay the cork over the top. However, if it's too late for that, I'll apply the spackling compound right over the top of the cork instead. Spackling is also good for filling gaps in the roadbed where the pieces didn't line up properly.

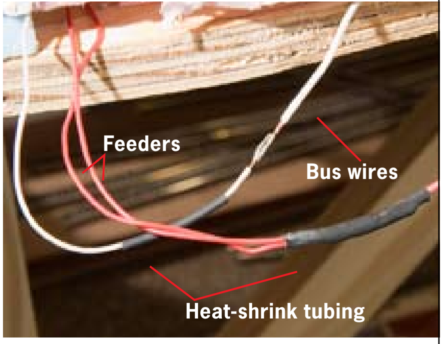
In this view of my Winsted addition, I've just finished painting the roadbed with black latex paint. I line my right-of-way with cinder ballast, and the paint makes the ballast layer look deeper than it is. It also allows me to get away with using very little ballast around the switch points.



My favorite track adhesive is dark gray latex caulk. I apply a bead of caulk down the centerline of the roadbed (avoiding switch points), level it with a putty knife, and then set the track into the material. You want it thin enough that it doesn't ooze up to the tops of the ties.

Once the track is aligned, I tack the track in place with a few T pins and then weigh it down overnight with bricks. If I need to pull up a section later, the track can be released from the caulk with a putty knife.

While the caulk is drying, I drill holes through the roadbed and scenery and slip the feeders through them. Later, after I've checked everything for good electrical contact, I fill the feeder holes with caulk.



The last step is to attach the feeders to the track bus. I solder these connections and, as shown in the photo, cover the exposed wires with heat-shrink tubing. With that, I test run a locomotive over each track.

Accurate curves

Laying track accurately on curves by eye is a tricky proposition. For better results, I use a homemade trammel, built from an awl and a yardstick. To make the trammel, I drilled a hole in a yardstick ½" from one end. The hole is big enough for the metal shaft of the awl to fit through. Since I use foam insulation for my scenery, to work the trammel, I simply stick the awl in the foam at the desired location.

As shown in the photos, I not only use the trammel to mark track centers on the curves on the layout, but I also used it to make sure that I lay the roadbed and track accurately.

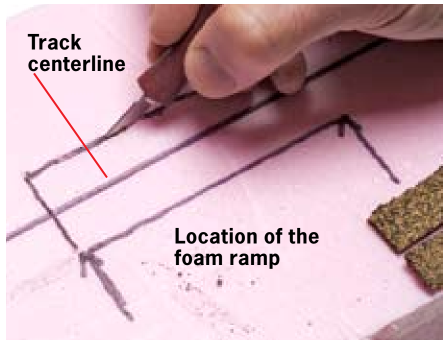
Construction of my track trammel is simple: The main components are a yardstick and an awl, and the best part is that when they aren't being used as a trammel, they can still be used as ordinary tools.

After setting the flextrack in wet caulk, I use the trammel to align the rails to match the correct curve radii. I then pin the track in place until the caulk sets. The trammel produces a smooth curve every time.

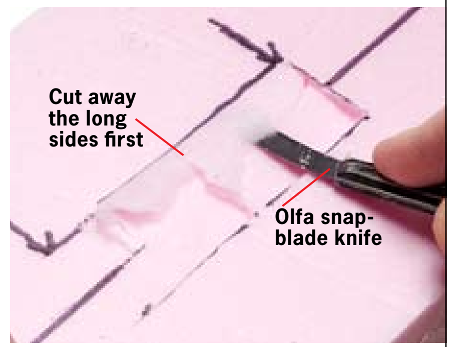
Making transition grades

Though my main line tracks are laid on cork roadbed, many of my industry spurs are laid below the height of the main line for added realism. Since I use foam insulation board as my scenic base, making the transition from mainline level to that of the industries required some thought. While I could taper the roadbed to ground level by sanding it, that requires a lot of work.

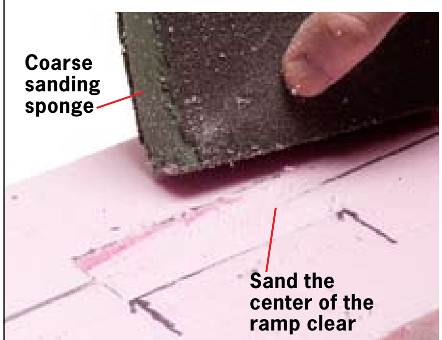
Eventually, I hit upon the idea to cut a ramp into the foam. Then, by laying the roadbed into the ramp, it would bring the top of the cork to the same elevation as the top of the foam scenery. This proved both easy and effective. Following are the steps I use to make the roadbed transition grades.



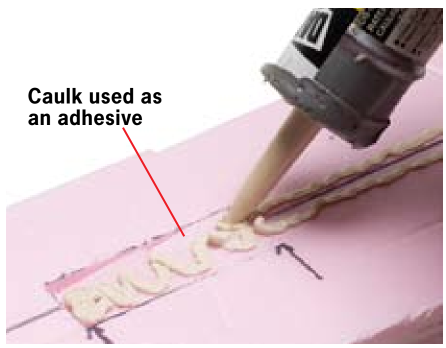
First I mark the centerline for the track on the foam scenery surface, then I mark the distance needed for the ramp. In N scale, it usually works out to be 4" to 6" long. I trace the width of the cork roadbed onto the foam, and then using a hobby knife, I cut the outline of the ramp.



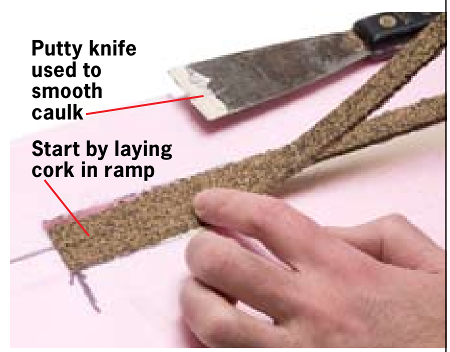
To cut out the ramp, I use a snap-blade knife made by Olfa (www.olfaproducts.com). These knives have long, thin blades, making them great for cutting deep into the foam. As shown in the photo, I use the knife to cut away foam from the three sides of the ramp.



I use a coarse sanding sponge to remove the foam from the raised area in the center of the ramp. I check my work by testing the fit of the cork roadbed because it's easy to dig too deeply. The roadbed needs to be flush with the top of the foam at the end of the ramp.



After vacuuming the foam dust from the work area, I cement the cork in place with latex caulk. On occasions where I've made the ramp deeper than I'd like, I've filled it with more caulk than usual, being careful not to sink the cork below grade by pressing it into the caulk too forcefully.

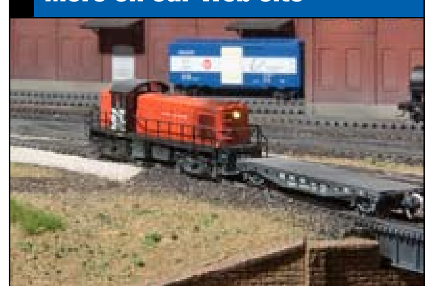


Before laying the cork, I smooth the caulk to a depth of about 1/16" using a putty knife. Though you can lay the cork directly into the bead of caulk, it makes it more difficult to achieve an even surface for laying track. I lay the cork into the ramp first, and then back to the main line.

As with laying any roadbed on my layout, once the cork is positioned in the wet caulk, I use a wallpaper roller to press it home, smoothing out areas that may have too much adhesive under them. Again, use caution around the ramp, to avoid sinking the cork below the foam.

With the ramp finished and the caulk dry, I then lay the track as on any other part of the layout. The photo shows that the completed ramp makes an effective transition between the main line roadbed height (at right) and the surface of the foam scenery (ground level), at the left.

More on our Web site



Go to www.ModelRailroader.com and look under Online Extras to watch a video showing some of David's N scale track tips. As a bonus, you'll also get a short tour of the newest addition to David's N scale New Haven layout, the branch line to Winsted, Conn.

Prototype track basics

An introduction to rail, ties, ballast, and more

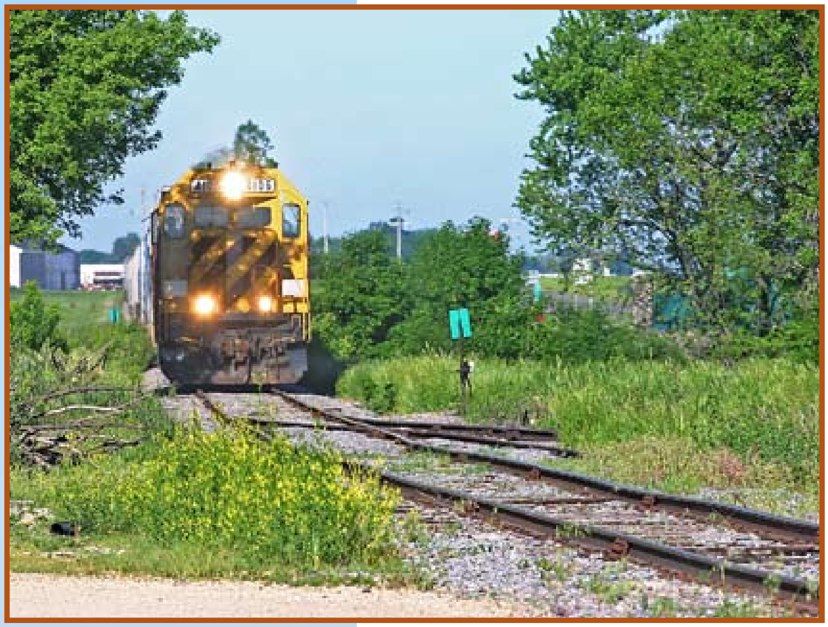
by Jeff Wilson

When we observe prototype railroading, our eyes usually gravitate to the locomotives and freight cars, as well as to the surrounding scenery and structures. However, it can be easy to overlook the track itself.

The rails, ties, and roadbed are all worthy of our attention, as they make up the steel roadway that makes railroad operations possible. Trackwork includes a variety of details and nuances worth modeling. Track components have evolved through the years, and modeling these details accurately will make our layouts and scenes more realistic.

Brief history

The first railroad tracks of the early 1800s certainly didn't resemble those of today. The "rails" consisted of iron straps secured atop heavy wood timbers. This proved barely adequate, even for the slow speeds and lightweight equipment of the day, as the straps tended to peel off the timbers –



A Minnesota Prairie Line train rocks and rolls into Gaylord, Minn., at 5 mph. Note the light, jointed rail, low ballast profile, weeds encroaching on the tracks, and numerous undulations on this former Chicago & North Western branch line. Jeff Wilson photo

This well-maintained double-track Union Pacific main line in Nebraska has welded rail on both lines, anchors at every tie, and a tall ballast profile. The line sees dozens of trains each way every day, including many heavy unit coal trains. Jeff Wilson photo

sometimes curling upward and spearing cars and riders.

To solve this problem, railroads in the 1830s began laying rolled iron rail that, although small, had a profile resembling what we now think of as railroad rail. This early rail was made from iron, which – although superior to iron straps on wood – was brittle and prone to breaking. Wrought iron proved to be much stronger, and was used for most rail until steel began appearing in the late 1850s.

Many of the first railroad lines in the United States featured rails anchored to stones. Railroads of the day thought this represented a durable, long-lasting installation compared to less-expensive timber ties. However, stones were prone to shifting, throwing track out of gauge and vertical alignment. Timber ties proved much better at keeping track aligned and providing a smoother base for the rails.

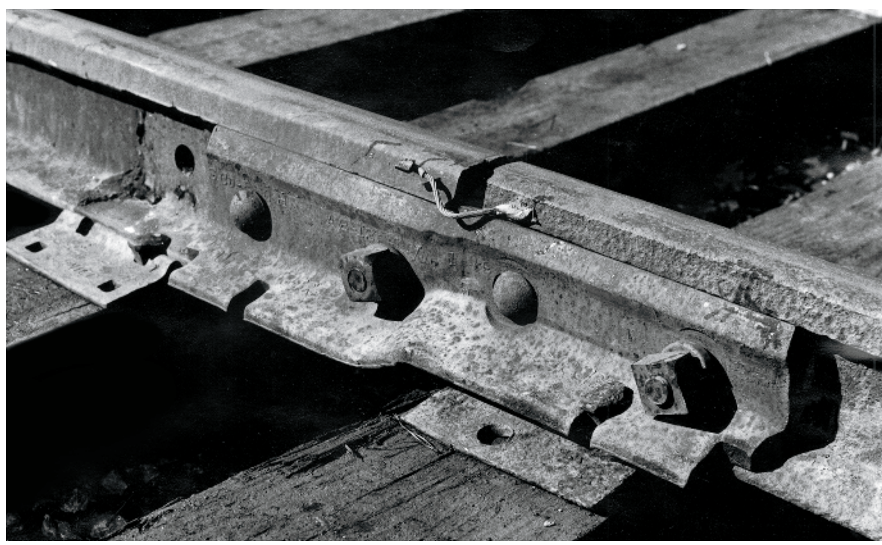
The standard North American track gauge of 4'-8½" was based on English tramways. Although this gauge was used by many early U.S. railroads, some, especially in the South, built their lines to other gauges. In 1863, the first transcontinental railroad was mandated to use a gauge of 4'-8½", effectively establishing that as the standard. However, it didn't become official until 1887. That year saw a massive undertaking when crews re-gauged thousands of miles of track over a single weekend.

Prototype track offers a wealth of variety and detail worthy of modeling. You certainly don't have to model every bolt and rail anchor to have realistic track, but capturing the differences in the many types of track will lead to a better-looking model railroad. Let's take a look at what makes up the track structure.

Jeff Wilson is a former Model Railroader *associate editor who has written numerous books and dozens of articles on model railroading. His latest book is* Building a Ready-to-Run Model Railroad *(Kalmbach Books).*

Rail

Rail is labeled with the maker and weight. This 112-pound rail was rolled at Bethlehem Steel's Steelton, Pa., plant in 1934. It is in service here on Conrail in 1978. Tom Nelligan photo



This compromise joint bar connects rails of different weights and heights. The bond wire welded between the rail ends maintains an electrical connection for signaling purposes. John W. Coniglio photo

The familiar rail cross-section has been around since the late 1800s, albeit with some minor contour modifications and increases in size. The fat part at the top that supports the wheels is the "head." The "web" is the narrow vertical component, and the flat bottom is the "base."

Prototype rail is classified by its weight in pounds per yard of length. Most modern mainline track uses 115- to 136-pound rail, needed to support the high speeds of today's 110-ton cars and heavy diesel locomotives. At the turn of the last century, when equipment was much lighter, 100-pound rail was considered heavy, with much track laid with 60- to 70-pound rail.

Lighter rail is used for industrial spurs, sidings, and other track that sees lower speeds and less traffic. Many light-rail spurs have restrictions against locomotives (or locomotives of specific classes) and cars above a certain weight. Modeling these restrictions can add an interesting twist to operations.

Most rail is jointed, meaning that it comes in short sections that must be bolted together end-to-end. Since the early 1900s, the standard length for rail sections has been 39 feet, a length selected because it will fit in or on a 40-foot gondola or flatcar.

Jointed rail is held together by heavy metal straps or angles called "joints" or "joint bars." These are made in different styles, with either four or six bolt holes. Six-hole versions are common on main lines, with four-hole versions elsewhere.

Insulated joint bars are used where rail sections or blocks must be isolated electrically, such as grade-crossing circuits and signal block boundaries. These have separate steel pieces on each rail with an insulator between the rails. They are often painted orange.

In signaled areas, bond wires are installed between rail ends to connect them electrically. These wires are welded on the outside of the rail.

The best solution to the maintenance problems of jointed rail is continuous welded rail (CWR). Rail sections are welded at the mill or factory to 1,500-foot lengths. Multiple sections of CWR are carried on specially designed cars to the site. Once laid, these sections are welded together to make even longer sections, which can be several miles in length.

Welded rail first appeared in the United States in the early 1930s, but wasn't perfected until the late 1950s. Today, welded rail is the standard for main lines and and on many secondary and branch lines, with nearly 100,000 miles in service across the country.

Ties

Early wood ties were rough cut, often with only the top and bottom planed flat, and in varying lengths. Mills began turning out ties to specific dimensions in the late 1800s, and by the early 1900s a typical tie was 6" thick, 8" wide, and 8 feet long. By the 1940s the standard had grown to 7" thick, 9" wide, and 8'-6" long. Today, 9-foot-long ties are common.

Wood ties are pressure-treated to make them resistant to decay and insect infestation. Creosote has long been the preferred preservative. The treatment makes new ties dark brown to black; the colors fade over time to shades of gray and lighter brown.

To keep ties from splitting as they dry and age, metal reinforcements called "tie irons" are often driven into the ends. These can be a square or other patterns, or a spiked metal mesh.

Tie spacing varies depending upon track capacity, with closer spacing on main lines and wider spacing on spurs and other less-used tracks. A spacing of about 20" from center to center is common. There's usually at least 10" between ties to allow room for tamping ballast in place.

In the 1800s it was common to lay rail directly atop the ties. But rails could bite into the ties and work themselves out of gauge. The solution was the tie plate, a flat steel plate with grooves to guide the rail and square holes for spikes.

Rail anchors are common on main lines and many secondary tracks. Many designs can be found, but most are C-shaped metal pieces that pass under the rail and clamp securely to the rail base at the edge of each tie. This effectively clamps the tie to the rail, keeping the rail from "creeping," or moving along its length. Rail creep tends to follow the direction of heaviest traffic, or downgrade on steep hills.

In the late 1950s, the Association of American Railroads (AAR) began testing several types of prestressed concrete ties and fasteners. In 1960 and 1961, several roads installed test sections of concrete ties on main lines. These tests revealed problems, including ties cracking from loads and abrasion that caused the tie to erode under the rail, especially on curves. Development of pads between the rail and tie solved most of the early problems. By the 1980s, several railroads began installing concrete ties on main lines, and today, many large railroads have significant stretches of track on concrete ties. Concrete ties are wider (about 11") than wood ties, 9 feet long, and are spaced wider than wood ties – about 24" to 30" center-to-center.

Composite ties have also been laid in limited numbers, including wood encased in plastic as well as ties made from recycled plastic and recycled rubber. These can be used as replacements for wood ties, with various types mixed on the same line.

Steel ties, although used successfully overseas, have seen limited use in the United States. They're durable and recyclable, but have a high initial cost, and create problems with signal systems that require the rails to be electrically insulated from each other.

This mainline track has wide tie plates spiked to the tie separately from the rail spikes, with rail anchors installed on both sides of every other tie to prevent the rail from creeping. Gordon Odegard photo

Concrete ties, such as these on the Union Pacific near Lewellen, Neb., can be found on many main lines throughout the country. Concrete ties tend to be wider than wood ties, and more widely spaced. The contour drops in the middle, and ballast often covers the middle of the ties. Jeff Wilson photo

Ballast and roadbed

The two mainline tracks on this Union Pacific line have a high ballast profile with welded rail. The next nearest track is a passing siding, which also has welded rail but a noticeably lower ballast profile. The two nearest tracks are spurs to a grain elevator. They are at ground level, have jointed rail, and have little to no ballast. Jeff Wilson photo

Ballast is the layer of crushed rock that supports the ties. Ballast elevates the track above the grade and allows drainage. It also provides even distribution of the weight of the track and holds the track in alignment, keeping it from shifting. The ballast structure allows the track to be leveled and aligned as needed by tamping or adding more ballast.

The illustration below shows typical profiles for track, ballast, and subroadbed. Ballast depth below the bottoms of the ties can range from 6" for sidings and light-use tracks to 12" for main lines through the steam and early diesel eras to 20" or more for modern main lines with welded rail. Main lines are more likely to feature a well-defined profile, with wide ballast shoulders outside the ties on each side. Sidings and spurs will have lower profiles.

A double-track main line will feature even height with identical ballast profiles on both tracks. A passing siding, on the other hand, will have a lower ballast profile than the main, making it easy to spot.

The first tracks were dirt-ballasted, with the dirt often crowned over the center of the ties to facilitate drainage. Later, some spurs and branch lines were laid on a very thin layer of ballast, or on a light bed of cinders. Over time, ties with such inadequate ballast can sink into the ground and become uneven. Vegetation often overtakes these tracks.

Railroads today use many types of rock for ballast, including granite, limestone, and trap rock. The key is that the rock be hard and resistant to wear, with sharp edges that lock into each other for stability.

Ballast can be obtained from local sources or mined at railroad-owned quarries. Often the owner of a rail line can be identified by the color of the ballast on the tracks, one example being the Chicago & North Western's distinctive "pink lady" quartzite ballast, mined near Rock Springs, Wis. Other ballast appears gray, tan, or white, or has a salt-and-pepper appearance.

On a main line, the ballast rests atop the subgrade – earth that has been built up, graded smooth, and packed to provide an even profile. The subgrade is crowned in the middle to aid drainage. A sub-ballast layer (made of rock crushed finer than the ballast) is sometimes used between the ballast and the subgrade. The subgrade is wider than the ballast base, providing a visual step or shoulder in the roadbed contour on well-maintained lines.

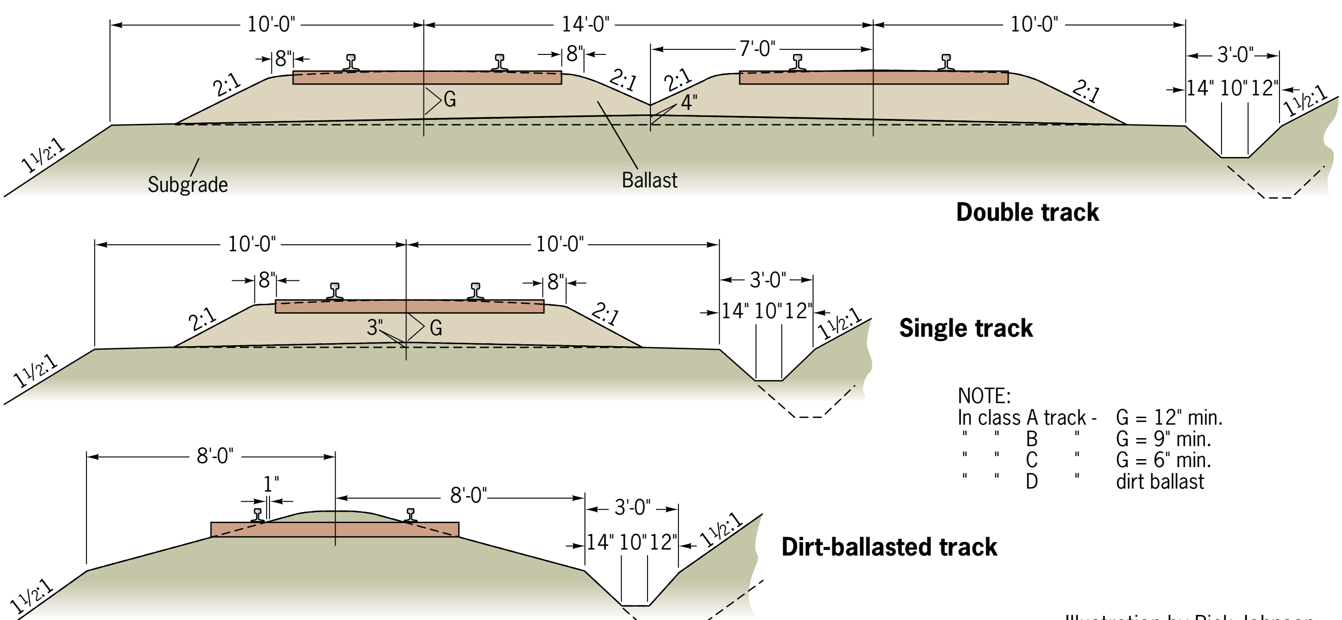


Illustration by Rick Johnson

Bumping posts

Heavy-duty bumper posts are typically found on heavily used spurs or where buildings are located directly behind the end of the track. Glenn A. Wagner photo

The ultimate in cheap track bumpers is a pair of ties buried in the roadbed. A pile of dirt or ballast could serve the same purpose. Harold Russell photo

Where tracks come to an end, railroads often install some type of device to keep cars from rolling off the end of the rails and to protect the property beyond the end of track. Many types and styles can be found.

Heavy-duty bumping posts are anchored to the rails or ground at four points, and include a striker plate at coupler level. These can be found on heavily used tracks or where buildings or other valuable property is located directly behind the bumper.

Wheel stops are designed to catch the wheels only, with one steel piece atop each rail. These are extremely common, and can be found in several variations at the end of industrial spurs or yard tracks.

Railroads install more simple (and inexpensive) bumpers on seldom-used track. This can be a timber or timbers (often old ties) strapped to the rails or buried at the end of a spur.

Bridge track

Track on bridges varies depending on whether the bridge deck is ballasted or open. The deck of a ballasted-deck bridge is a broad trough. Ballast fills the trough, with the rail/tie structure on the ballast, the same as on the rest of the line.

On open-deck bridges, the ties are anchored to the bridge's longitudinal beams or stringers. These ties are spaced closer together (6" to 8" between ties) than in standard track to better spread the weight on the beams, giving "bridge track" a distinctive look compared to the adjoining track.

Bridges may have guardrails inside the running rails. These inner rails may have a lower profile than the running rail, and are often old rail salvaged from other locations. The ends of the guardrails are tapered inward and sometimes come to a point (similar to a turnout frog, but not as sharp). The purpose of bridge guardrails is to protect the bridge by keeping any derailed equipment upright on the track as it passes over the bridge. RRT

On an open (or unballasted) bridge deck, ties are spaced much closer together than in standard track. Jeff Wilson photo

A hinged derail and folding marker sign protect the main line on Matt Snell's HO scale layout. If the boxcar rolls, the derail will stop it before it fouls the main.

Fig. 1 The prototype. **This hinged derail is double-ended and will derail cars from either direction.**

Hinged derails: an operating accessory

A prototypical way to stop runaway cars

By Matt Snell/Photos by the author

It can be a problem when cars sitting on sidings move on their own. On the prototype, an unattended creeping car can result in catastrophe if it rolls into the path of an oncoming train. Though the consequences are less dire on our model railroads, such an accident can result in damage to prized models.

Unlike their prototype counterparts, our models aren't equipped with hand brakes to hold them in place. The use of extremely free-rolling wheelsets means that even a slight grade in the siding, warping of the roadbed, or bumping the layout while operating can lead to a runaway.

Over the years, creative and sometimes complex methods for solving this problem have been tried, including rods that can be extended upward through the track to catch the car's axles. While attempting to solve this dilemma on my own layout, I wanted a more prototypical-looking solution. I also wanted one that was easy to install, requiring no rods to be added under a layout already crowded with support beams, wiring, and electronic components.

Prototype railroads stop a creeping car with a derail. Derails are track devices that shove the car's wheels off the rail and stop it from moving farther, while causing minimal damage to the car and track. On industrial sidings that border main-line tracks or on tracks where unloading equipment has been attached to a car, hinged, manually-operated derails are the most common protection.

Hinged derails are manufactured by a variety of rail equipment companies, including Hayes, Nolan, and Aldon. The fairly standard design, an example of which is seen in **fig. 1**, consists of two main pieces: a base that's mounted to the ties and a derailing block that's placed on the rail, connected by a heavy-duty hinge. When in the derailing position, the block rests on the railhead, and in the non-derailing position, it's out of the way between the rails.

Since rolling a car over a derail unintentionally will cause major issues for both the train crew and track department, derails are generally painted bright, highly visible colors. They are also often marked with signs mounted beside the track (common in older eras) or on a staff attached to the derail that folds down when the derail is in the off position.

Making the model work

While searching for a solution to creeping cars on my own layout, I found several derail castings, including one originally produced under the Sequoia Scale Models detail parts line (now being produced by Turner Model

Works, tmwshop.com, as part number 2006SQ). The Sequoia white-metal casting matches a prototype double-end, hinged-block derail. When installed on the track, it will either act as a true derail or block cars from rolling in the first place.

Installing a derail on your layout is a fairly simple process. Much like the 1:1 scale derail, the Sequoia part is a two-piece casting, consisting of the derailing block and base.

To change the two-piece casting into a working model, begin by test-fitting the base onto a piece of track and inserting the flange on the bottom of the casting between the ties. If the flange interferes with the placement on the ties, remove the flange with a chisel blade or jeweler's file so the casting will sit flush on the ties.

In order to make the derail operable, it needs to be hinged so it can be opened and closed. Drill two no. 78 holes through the base casting, one at each of the corners that form an L angle close to the rail, as shown in **fig. 2**. Next, drill two holes through the "fingers" that extend from the top casting, locating these holes as close to the body of the casting as possible, as in **fig. 3**. The excess length of the fingers can now be removed with flush cutters or a file to ensure that the derail won't hang up on the ballast when operated.

Insert a length of .015" brass wire through the holes in the top casting and bend each end 90 degrees, forming a U shape, as I've done in **fig. 4**. This wire can now be inserted through the holes in the base casting, forming a hinge.

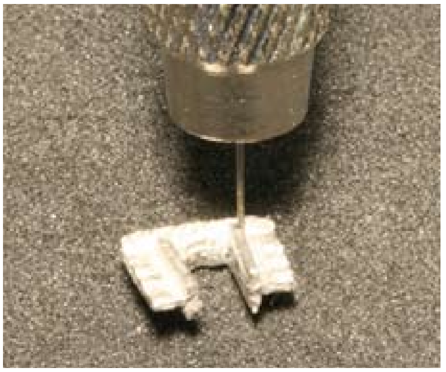


Fig. 2 Mounting holes. To convert the white-metal casting to a working model, Matt starts by drilling two holes in the base for the hinge.

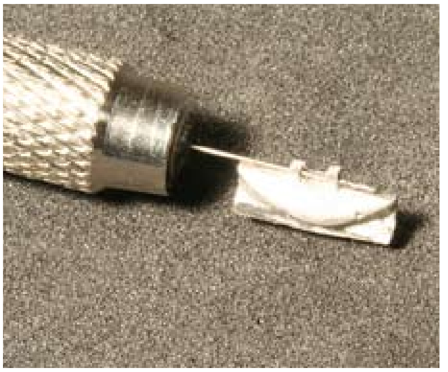


Fig. 3 Turning point. Matt drills a hole for the hinge through the "fingers" of the derailing block. The block will turn on a wire threaded through the holes.

Fig. 4 Forming the hinge. Looping a wire through the holes and bending the ends down forms the hinge on which the derailing block will pivot.

Fig. 5 Installation. To make the installation more secure, Matt glued the ends of the wire into holes drilled into the track and roadbed.

Installing the derail

First, paint the assembled derail Floquil Railbox Yellow. To model a derail with faded paint, simply choose a duller yellow, such as Floquil Santa Fe Yellow.

Before trimming off the excess wire, place the derail assembly onto a piece of scrap track and adjust the height of the derail block so it seats properly on the rail. See **fig. 5**. Then, trim away the excess wire with wire cutters. Apply a drop of cyanoacrylate adhesive (CA) to the underside of the base to secure the wire in place. However, if you'd like to strengthen the assembly, leave the wire long and drill holes for it into the roadbed. You can use CA to cement the excess wire into these holes.

Signs marking the derail can be added to the layout is several ways, depending on your modeling era. For those modeling older eras, a post-mounted sign can be placed next to the derail using sign kits or decals applied to a styrene background. Modern-era modelers can add a simple fold-down sign on the ties adjacent to the derail. N.J. International includes an operating fold-down sign as part of its no. 1308 blue safety sign set; its stick-on "Danger Men Working" lettering can be easily removed and the sign relettered for a derail using a white decal alphabet. You can see it in the photo at the beginning of this article.

When installing a derail on your layout, consider the length of cars that will be parked on that particular spur. Longer cars may have their wheels set back farther from the couplers than 40- and 50-foot cars. The derail should be placed in a location that will stop the wheels of the longest car without allowing the body to extend past the siding's clearance point. [The clearance point is the location within a turnout where there is at least a scale 13'-6" between track centers, or where the tracks become parallel. – *Ed.*]

The second consideration is ease of use. Since the derail will be manually operated, it should be within easy reach. Try to avoid placing it where buildings or trees can block the way.

Once an appropriate mounting location has been determined, the derail can be placed on the layout and tested to ensure there is ample clearance for low-hanging items such as locomotive pilots and plows. After making any necessary adjustments, secure the base in place with CA.

To open the derail, flip the hinged block backward off the rail. To apply it, flip the block onto the rail. Before your next operating session, be sure to inform your crews about the addition of the derail and show them how to use it. Then worry no longer about a car fouling your main track. RRT

Matt Snell works for a trucking company in West Chester, Ohio. His HO scale Conrail New Jersey Division layout appeared in Great Model Railroads 2006. *He and his wife, Debie, have produced several videos on the Conrail system.*

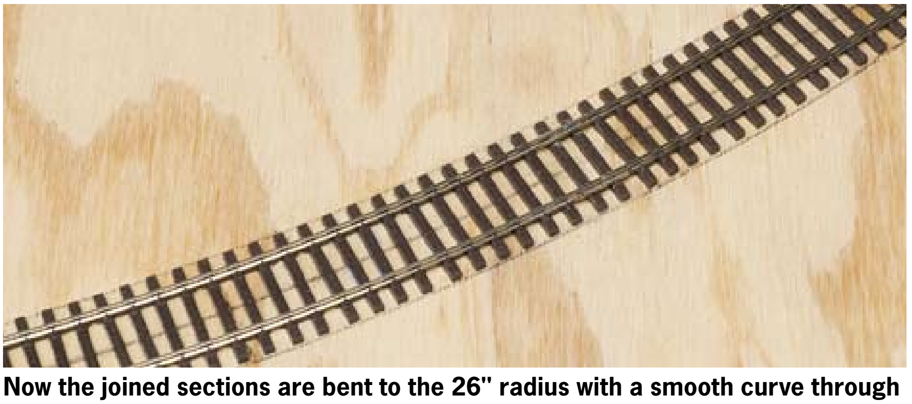
Track gang tip

Make kink-less curved rail joints

This method is good for flextrack and handlaid track too

The Atlas code 83 HO flextrack at left is laid on a 26" radius, except for the last three inches. After trimming the rails on that section for a square joint, Andy Sperandeo is ready to add a new section that's still straight. Bill Zuback photos

Andy has joined the two sections with rail joiners, and soldered the joiners with the rails still straight through the joint. Small-diameter rosin-core solder makes it easier to make a neat, strong joint without building up excess solder.



Now the joined sections are bent to the 26" radius with a smooth curve through the joint. Andy saves extra ties to fill gaps in the tie strip, and always cleans the joints with denatured alcohol to keep excess flux off wheels and railheads.

Model rails are easy to curve to whatever radius you need, all except for that last inch or so. Trying to bend that part of the rail for a smooth joint in a curve can test your patience, but there's definitely an easier way.

Make the joint on straight rail, solder it, and then bend the rail to the curve. The photos show how this works on flextrack, but I do the same thing when building handlaid track. The only difference is that for hand-laying I do one rail at a time. And though these photos show HO track, I learned this method years ago from Gordon Odegard's *Model Railroader* series on modeling the Clinchfield RR in N scale.

To curve flextrack smoothly, leave the last couple inches straight as you glue or spike the track to the desired radius. I prefer gluing with clear adhesive caulk.

Cut the rail ends square at the straight end of the section and trim away enough ties to make room for rail joiners. Also remove a tie or two on the next section while it's still straight. Don't discard the ties you remove, as you can use them later to fill the gap in the tie strip. Slip a couple rail joiners in place and you've reached the point shown in the **top photo**.

Now join the two sections and neatly solder the rail joints with the track still straight through the joiners. I like to use a little liquid rosin flux here to help the solder flow into the joiners, and afterward I clean up excess flux with denatured alcohol on an old toothbrush.

Keep in mind that it's the solder that flows inside the joiner that does the work, and a solder blob on the side of the rail only makes an unsightly mess. The **middle photo** shows the joints soldered but still straight.

Finally bend the new section and the last bit of the old one to whatever radius you're using and secure it, making sure to leave the last bit of the new section straight if it's still in the curve. The rail will curve smoothly through the joint as in the **bottom photo**, and you'll never again have to worry about kinks in your curved track. – *Andy Sperandeo*

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Conceal those uncoupling magnets

The only clues that there's a Kadee no. 309 electromagnet buried under this track are the two gray-painted ties. Andy Sperandeo paints the ties above the ends of the magnet pole pieces to show where to uncouple cars.

Bury them in your track bed and cover them with ballast

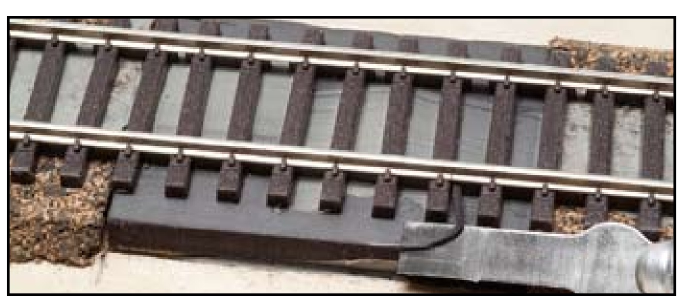
By Andy Sperandeo//Photos by Bill Zuback and Jim Forbes

Magnetic uncoupling can look like magic at work on your model railroad, especially if the magnets can't be seen. Kadee and other manufacturers offer both permanent magnets and electromagnets strong enough to work from below the ties. Using them takes a little planning, but figure out where to put them and you can build them into your roadbed, lay track right over them, and conceal them with ballast.

Electromagnets are usually activated with momentary push buttons, making them ideal for locations in main tracks and at both ends of double-ended sidings and yard tracks. Because they're only magnetic when you want to use them, they're also good for locations where a train or switch cut may be working over more than one magnet at once. Reserve the permanent magnets for single-ended spurs and yard tracks.

The photos illustrate some other tips for hiding uncoupling magnets. RRT

Andy glues a rectangle of .005" styrene over the buried Kadee no. 309 magnet so he won't have to fill the roadbed recess with ballast or have ballast fall through the opening in the plywood subgrade. Next he'll glue flextrack over the magnet with adhesive caulk.



The Kadee no. 308 permanent magnet is wider than the shoulders of some HO roadbed. Fortunately, this magnet is made from a rubber-like material that can be carved. Here Andy uses a knife to "break" the uncoupler's sharp corners so they won't show through the ballast.