

**Model  
Railroader**  
MAGAZINE

# WORKBENCH GUIDE

TOOLS • ADHESIVES • SOLDERING • ENGINE TUNE-UP  
TIPS • WORKING WITH BRASS • CONVERTING SCALES  
A SUPPLEMENT TO MODEL RAILROADER MAGAZINE



# The foundation of a modeler's toolbox

Essential tools to make your model railroading more enjoyable

**M**odel railroading is a creative hobby that's much more enjoyable if you have the right tools to do the job. Many tools are regular hardware store items, while the more specialized ones are sold by hobby dealers.

Tools come in a wide range of prices, but this is one place where quality is important. Buy the best you can afford, as good tools will perform consistently, and with a little care they'll last a lifetime. Their cheaper cousins tend to be made of softer metals so movable joints loosen and cutting edges wear out much faster.

This list of tools covers the basic ones most first-time modelers initially acquire. Naturally, there are plenty of other tools available to make more complex projects easier as you gain experience.

## The essentials

- **Hobby knife:** The most popular hobby knife has a lightweight knurled aluminum handle with a chuck at one end which holds a sharply pointed steel blade. You'll also want to pick up some replacement blades. Typical cost is \$3 to \$5 depending upon the number of extra blades included.

- **Needlenose pliers:** A 6" or 8" needlenose pliers with a built-in wire cutter is useful for everything from adjusting wheels to spiking track and wiring a layout. A good pair sells for \$12 to \$15.

- **Screwdrivers:** You'll encounter lots of tiny screws which require small screwdrivers. Look for ones with interchangeable bits or sets with sizes ranging from 1/16" to 1/8" plus Phillips sizes 0 and 1. Typical prices range from \$5 to \$7.50 for single reversible screwdrivers, while small sets will start around \$10.



Start your toolbox with a hobby knife, a good pair of needlenose pliers, and a set of small screwdrivers.

## Useful additions

- **Clamps:** As you build models, you'll find that parts must often be held in position while cement dries. A package of spring clothespins from the supermarket is an inexpensive source of clamps. Because they are made of soft wood, the clothespins may be easily trimmed for all sorts of special clamping situations.

- **Mill file:** A single-cut 8" mill file handles truing the edges on plastic kits, smoothing rail joints, and lots of other similar jobs. Don't forget to buy a handle to protect your hand.

- **Needle files:** These small files are about 6" long with extended tang handles and a variety of shapes. They're useful for cleaning flash off castings and filing small openings to exact size. Round and half-round files are the most useful, but sets also include flat, triangular, square, and equaling files. They're sold individually for about \$4 or in sets of six different shapes for around \$20.

- **NMRA gauge:** The National Model Railroad Association produces sheet metal standards gauges for all the popular scales, and they're readily available from hobby dealers. One of these gauges makes it easy to check the coupler height and adjust the spacing of wheel sets and track components for top performance. These gauges are \$10 each.

- **Paintbrushes:** Watercolor paintbrushes, in sizes 1, 2, and 3, have a lot of uses besides their intended function. Brushes may be used for cleaning and dusting, positioning scenery material, and applying liquid plastic cement. Brush prices start at about \$2 each.

- **Rail nipper:** This is a special pair of flushcutting pliers designed to cut soft brass or nickel silver rail in sizes up to code 100. It has a very delicate cutting edge that is easily



Needle files are good for cleaning out flash while the larger mill file finishes rough edges. Nonmagnetic tweezers help handle tiny parts.

BY JIM HEDIGER

damaged if you attempt to cut harder materials. Rail nippers sell for about \$25 in hobby shops.

- Soldering iron: Most modelers learn to solder electrical connections early in the game. A small 40-watt iron, similar to a wood-burning tool, will do the job for less than \$20, while a similar size soldering gun is about \$30. You'll also need rosin-core solder with a 60-40 alloy (60 percent tin and 40 percent lead).

- Tweezers: Fine-pointed, good-quality tweezers make it easier to handle small parts. Look for nonmagnetic tweezers with perfectly matched machine-ground serrated points (either curved or straight). Misaligned tweezers are useless as the gripping pressure will launch small parts into never-never land. A pair of good tweezers sells for \$6 to \$10.

### Care and handling

Even though they're small, modeling tools require the same care and respect given to their larger counterparts. Think about how much force you're exerting on a small area as you use them. It's easy to damage tiny screws, so use the right size and type of screwdriver and don't overtighten them. Be aware of where the tool is headed if it slips – tiny screwdrivers and hobby knives can inflict some painful wounds.

Hobby knives are extremely sharp, so little pressure is required to make a clean cut. Use a safety cap to prevent accidents when the knife is stored. Blades are inexpensive and dull ones should be replaced for best results. I use a 35mm film can to hold the discarded blades until they can be disposed of safely.

Needle files are hard and brittle, so it doesn't take much side pressure to snap them off. A smooth, gentle motion cuts the best. If the file gets stuck in an opening, wiggle it gently in a counterclockwise circular motion until it comes free. Use a brass suede brush to clean these files. Brush across the file, parallel with the teeth, to clear the debris.

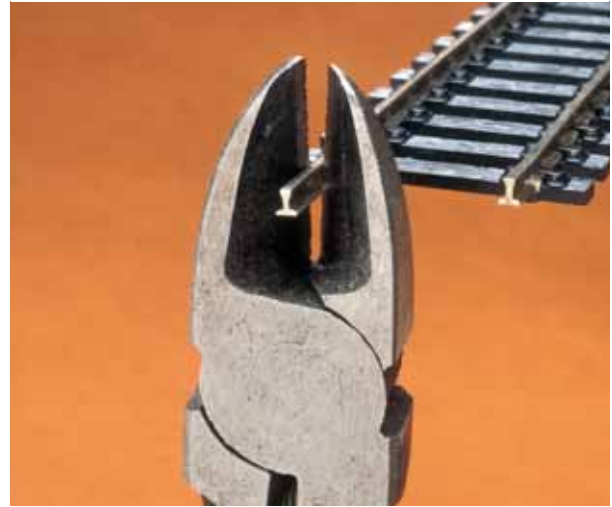
Make sure the surrounding area is clear and wear safety glasses whenever you use rail nippers as the small pieces of rail will go flying as they're cut off. They work best by making two cuts: a rough one to get close and then a final trim that shaves a thin sliver off the end without crushing the rail's cross section.

Finally, soldering creates heat so you need to be careful to let things cool. Some items, like code 100 rail, retain the heat for several seconds after the solder solidifies. (I still have a pair of HO gauge stripes on my forearm from leaning on a track too soon!) Don't forget to disconnect the soldering iron when you're done to eliminate a potential fire hazard.

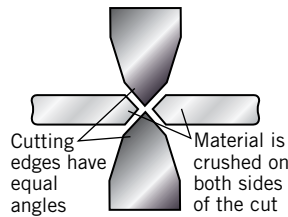
The important thing is to be patient and let the tools do the work. Forcing a cut or applying undue pressure on anything usually results in disaster.

Learn each tool's capabilities and, as you gain experience, you'll find that building a model railroad will become even more enjoyable.

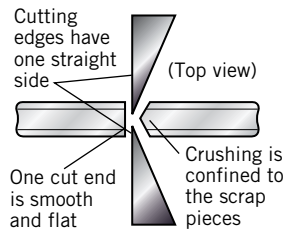
## SIDE-CUTTING PLIERS VERSUS RAIL NIPPERS



SIDE-CUTTING PLIERS

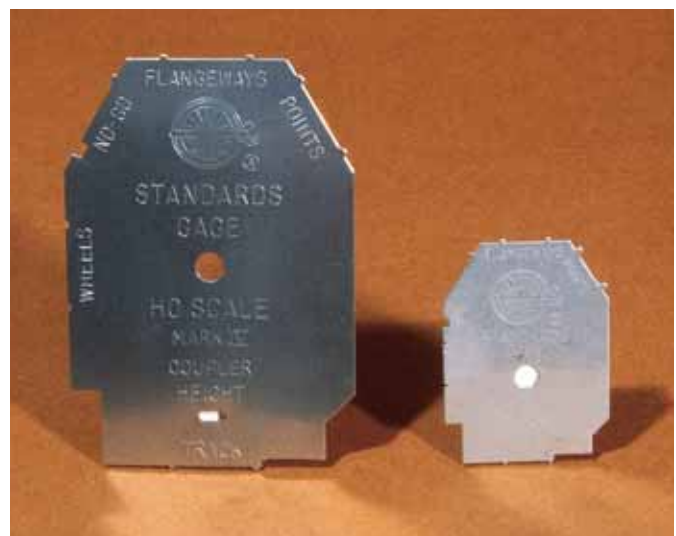


RAIL NIPPERS



While they may look similar, these two pliers have different cutting edges. Ordinary side cutters have v-shaped cutting edges that partially crush the material on both sides as the cut is made.

Rail nippers are also known as flush-cutting pliers. They have specially ground edges so metal is crushed only on one side of the cut, leaving the good side smooth and flat. But the thin cutting edges of rail nippers are very fragile and easy to damage. Don't even try to use them to cut wire or anything harder than brass or nickel silver rail. – Jim Hediger



Get the appropriate NMRA gauge for your scale to measure wheels and track spacing as you make adjustments to improve performance.

# What you need to know about adhesives

Advice to help you choose the right glue for the job

**O**ut there in the “real world” things are nailed, screwed, bolted, riveted, and welded together. On our models, though, almost all such connections are made by adhesives – glues. The chart below shows the qualities of each glue and recommended application. However, I’ve arranged this article by the material to be joined – metal, wood, plastic – rather than by glue type. After all, we don’t sit down in our shops, pick up a tube of glue, and say, “What can I build with this?” I’ll begin with the toughest materials to glue and work toward the easiest.

## Cementing engineering plastics

You can’t. Well, that’s not quite true, but most plastics which get this label resist gluing. Acetal resins are the type most used in model railroading. They’re often referred to as “engineering plastics,” the most familiar brand name being Delrin. They’re used for trucks, handrails, gears, stirrup steps – anywhere that plastic needs to be very strong or to serve as a bearing.

Small acetal parts can be attached with cyanoacrylate adhesives (CA), but what you’re doing is surrounding the part, or a piece of it, with CA, which then holds it in place mechanically. You can similarly glue pieces made from Teflon, nylon, and other engineering plastics, but all of these joints will be very weak.

## Joining metal

Epoxy resins can bond metal to metal with almost the strength of solder. For most people the main advantage of epoxy over solder is the ability to reposition parts, as it takes five to 20 minutes to cure. But this setting time can be a drawback as the pieces must be held in position for that long. Epoxy also works well for joining metal to virtually any other material.

Cyanoacrylate adhesives (CAs, also called super glues) are excellent for joining metal to metal and metal to almost anything else. The thin CAs produce the quickest and strongest

joints, but the joint must be very close-fitting. The best approach is to assemble the pieces, then just touch the CA to the joint and let capillary action draw it in – the less glue the better. The thicker, or “gap-filling,” CAs do not require snug joints. These should also be used when gluing metal to porous substances such as wood or cardstock.

General purpose glues, such as those made by Ambroid and Duco, can also be used for low-stress metal joints, like adding weights to rolling stock. Sometimes their fumes can attack plastics, so try double-sided foam tape instead. It’s easy to use and won’t harm a thing.

## Welding styrene

Styrene is the most common plastic in model kits. It’s cheap, easy to cast, and more than strong enough for most parts. It’s also incredibly easy to glue. The adhesives we think of as “plastic cements” are actually solvents. They dissolve a layer of plastic on each piece and weld the two together.

Besides all the brand name glues you can also use methyl ethyl ketone (MEK), available at hardware stores.

Like CAs, plastic glues vary in thickness. On the thin side, but arranged in increasing viscosity, they are MEK, Tenax 7R, Testor’s liquid plastic cement, and Plastruct’s Plastic Weld. “Airplane glue” is at the gel end of the scale.

The thin cements work very well and produce almost invisible joints on tight-fitting seams. However, as with CAs, you may find the thicker ones more useful when gluing parts that don’t mate closely. Testor’s Model Master Liquid Plastic Cement is thicker than most and has a needle-tube applicator, allowing you to apply a precise amount. This gives you the slow setting time needed to position parts and still have neat joints.

There’s no advantage to using CAs for styrene-to-styrene joints, but they will work. For gluing styrene to other materials, CAs are usually the preferred choice. However, general



## ADHESIVE COMPARISON CHART

ADHESIVE	SETTING TIME	CURING TIME	STRENGTH	COLOR	BEST APPLICATIONS
Cyanoacrylate	5 to 60 seconds	2 hours	high	clear	metal, plastic, wood
Contact cement	on contact	24 hours	medium	light brown	cardstock, plastic, Styrofoam, wood
Epoxy	5 to 20 minutes	12 hours	high	clear, amber	cardstock, metal, plastic, wood
General purpose	10 to 20 minutes	12 hours	medium	clear, amber	cardboard, metal, styrene, wood
Plastic cement	30 sec. to 1 min.	8 hours	medium	clear	styrene
White glue	10 to 60 minutes	24 hours	high	clear	cardstock, plaster, scenery, wood
Yellow glue	10 to 40 minutes	24 hours	high	clear	cardstock, plaster, Styrofoam, wood

BY GEORGE SEBASTIAN-COLEMAN

purpose glues will usually provide a satisfactory bond. Contact cements (Walthers Goo is one; there are many others including spray-on types) will give the best results when gluing sheets of plastic, such as brick sheets, to one another or to some other material.

### Gluing wood, cardstock, and plaster

These are perhaps the easiest items to glue because they are porous. However, many adhesives won't work on them. The very thin CAs generally won't work, nor will the plastic cements. The most useful glues for joining one porous material to another are the familiar white glues, like Elmer's Glue-All, and yellow glues such as Titebond's Carpenter's Wood Glue. Both clean up in water, but the yellow glues will resist dissolving in water once set. You can also thin both with water, but this greatly reduces their strength and should only be done when you want the glue to soak deeply into a material, track ballast for example.

As they were for styrene, contact cements are the choice for gluing large sheets of wood or paper together. Contact cements are applied to each surface, allowed to partially set, then the two parts are pressed together. Because this joint is permanent, you must be careful to align the parts correctly the first time.

### Scenery glues

The most common bonding challenge in scenicking a layout is joining a loose accumulation of ground cover or ballast into a solid unit. You can use thinned white glue for this purpose, but it can leave an unrealistic sheen. Acrylic matte medium – available at art stores – will provide a good bond yet leave the ground looking dry. Several manufacturers offer their own version of this material, such as Life-Like's Landscaping Cement.

Heun Enterprises' Movable Model Glue and Tac-n-Place are two more variations on white glue. These glues remain tacky so you can remove a part and then replace it. I've also found them very good for adding glazing to windows.

Spray adhesives, such as Floquil's All Purpose Scenery Spray Adhesive, can be used to affix ground-foam foliage to trees or as a bond for ground cover. It also functions as a spray-on contact cement. Inexpensive hair spray, the cheaper the better, also works well for attaching ground foam to tree trunks.

Foam insulation board can be put together with white glues by applying a thin coat to both pieces, letting them dry a bit, and pressing together. You can also use construction glues – Liquid Nails for Projects is the best known. You should test these first as some brands have solvents which may attack the plastic – don't worry if they eat in a little, as long as they hold. Construction glues are also excellent for putting up backdrops and for adding fascia board to the front of the layout.

## TAP DIMENSIONS

Threaded holes have two major dimensions: tap and clearance. A tap drill makes a hole smaller than the outer diameter of the threads, but larger than the shank. The clearance hole allows the screw to pass through freely. When assembling two parts, clamp the parts and drill both with the tap drill. Separate and use a clearance drill on the upper piece.

Tap only the bottom piece. It's the screwhead that secures the pieces to one another. If you thread both parts, you'll never get them tight (unless you can spin them about the screw independently). – *Stephen Anderson*

## DRILLING AND TAPPING

- Drilling an accurately located and sized hole usually requires progressive drilling, that is, starting with a small pilot drill and gradually enlarging the hole to its final size.

For example, to drill a no. 55 hole, start by carefully drilling a no. 66 pilot hole. Use plenty of light oil on the bit as you drill. Remove the drill often to clear the chips that build up on the cutting edge. Then enlarge the hole first with a no. 60 bit and finish with the no. 55. This technique takes a few minutes longer, but it is well worth the effort.

- Tapping a hole (cutting the threads for the screws) is not difficult if you are careful. There are two drill sizes associated with tapping, called the tap drill and the clearance drill. The tap drill makes a hole slightly smaller than the outside diameter of the threads. It is this hole that you actually tap.

When tapping a hole, use plenty of light oil and remove the tap often and clean all chips from the tap by moving it across your finger. Use light pressure on the tap. You should never have to force a tap; good taps cut easily. Also, periodically reversing the tap a quarter turn frees chips from the cutting edges and makes tapping easier.

Remove and clean the tap for a small hole at least three times while tapping it. If you think this is tedious, remember there's nothing more frustrating than breaking a tap in a hole and having to remake the entire part because you can't remove it. – *Stephen Anderson*

### Safety

Many adhesives or their fumes can irritate your skin, eyes, and the membranes in your nose and mouth. All vapors should be considered potentially toxic. Always work in a well-ventilated area and take frequent breaks. Stop immediately if you feel dizzy.

The most hazardous adhesives are CAs because they can instantly glue skin to itself and anything else. Acetone, nail polish remover with acetone, and special debonding agents can help free you.

Should you get an adhesive in your eye or another sensitive area, get medical attention immediately – do not pry apart! A foam bottle holder is a handy accessory to have: It will keep bottles of CA and other glues and paints from spilling and ruining you or your models.

### Sticking to the subject

There are other glues out there and with the daily advances in material engineering you can be sure there will be new ones soon.

The best way to discover what works for you is to try them all. The glue one person swears by may be the one you only swear at. With all the choices, however, you should be able to make almost anything stick together.

# Learning the art of soldering

Soldered wire connections are a must for good electrical contact

**S**oldering may not be necessary to build fine-looking locomotives for your layout, but if you want them to move you still need to master the basics of soldering wire connections.

## How solder works

Solder joins metals together by creating a molecular bond between itself and the various pieces to be joined.

To accomplish this the metals to be joined must first be heated enough that the solder melts when it touches them. Merely putting molten solder on a joint won't produce a strong bond, if it produces a bond at all. The second requirement for a good bond is that the surfaces be clean – that is, bare metal – free of oxides or dirt and grease.

## The secret

There isn't one. You simply put the two ideas I've just explained into practice – clean surfaces sufficiently heated.

## Getting heat

There are lots of ways to heat the parts you want to join, but the most common for wiring, and happily the least expensive, is the electric soldering iron. These are available in a variety of wattages – some are even adjustable. The higher the wattage the more heat available.

For most wiring applications a 40-watt iron will be plenty. For working around electronics a 25-watt iron may be more convenient. With its trigger on-off feature, you may find a soldering gun useful for working under the layout and with larger diameter wires or parts.

Just as the metal to be joined needs to be clean, so does the tip of the soldering iron. File the tip clean, coat it with flux (a liquid or paste which prevents oxidation of the metal while it's being heated), melt some solder onto it, and then wipe the solder off with a damp rag. Keep a damp sponge near your work area and wipe the tip on it after each use to keep it bright. A bright tip will transfer heat more quickly.

## Cleaning up

Wire which has been freshly stripped of its insulation shouldn't require any cleaning beyond the use of flux. Wire or brass pieces that are dirty or oxidized will require some abra-

sive cleaning. Sandpaper, steel wool, files, or just scraping with a knife can all be used to clean a metal surface. Clean the metal just before you solder. Once you have a shiny surface, apply some flux.

Flux comes in many forms, but the most common and useful for wiring is liquid rosin flux in a squeeze bottle. Drops of flux can be squeezed directly onto the joint or you can make a small puddle on your work surface and use a brush to apply it.

Never use acid flux on electrical connections. Indeed you really shouldn't need anything but rosin flux for most model railroad applications.

## Making connections

Several recommended ways to splice two wires are shown below. In most cases you can make your splice, apply flux, then heat and add solder. However, if it's difficult to support the wires, it's best to tin each wire – lightly coat it with solder – before making the splice.

To tin your wire, strip away the insulation, put some flux on the exposed wire, touch the iron to the end of the wire, and apply solder near the insulation. The solder will melt and flow toward the tip.

Now when you make your splice you probably won't need any additional solder, so you'll be able to support the wire with your free hand. The drawback to this method is that the tinned wires are more difficult to wrap around each other.

Soldering electrical feeders to rail follows the same basic steps as a wire-to-wire connection. Some additional tips are shown in the photos on the next page.

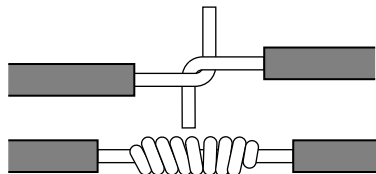
Use plenty of heat so the solder melts quickly. This will keep the ties from melting. Also, you don't want to disturb a solder joint as it cools so do not use the iron to hold the wire in place.

## Other projects

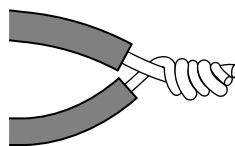
Once you've gained confidence with these simple connections, you'll realize soldering is not hard and you'll want to do more. Just remember, the requirements for a good joint don't change regardless of technique or material: You always need clean surfaces sufficiently heated.

### WIRE SPLICES

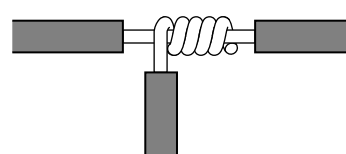
**WESTERN UNION SPLICE** – the strongest and neatest connection, works best with wires of the same or almost the same sizes



**PIGTAIL SPLICE** – good for joining wires of different sizes



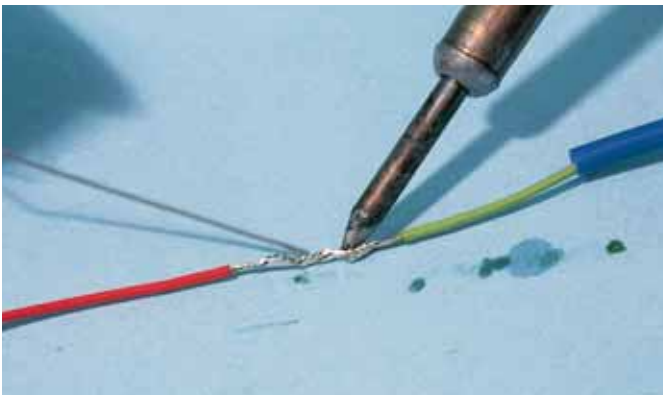
**TEE SPLICE** – for connecting a wire along the length of another wire



BY GEORGE SEBASTIAN-COLEMAN



This simple Tee splice connects wires under a layout.



A Western Union splice is the preferred choice for end-to-end connections. Note the heat-shrink tubing to the right.



The heat-shrink tubing has been slipped over the joint and is being shrunk by rubbing the warm side (not tip) of the iron on all sides.



**SOLDERING RAIL FEEDERS.** 1. After inserting the feeder through the roadbed, put a 90-degree bend in it and tin. Scrape away any weathering or corrosion on the rail, then flux and tin it.

2. Bend the feeder so it rests against the rail's web under the head.

3. You can use an aluminum soldering tool to hold the feeder in place as you apply heat. Be sure your iron is hot so the solder melts quickly. **Note:** In smaller scales and for those new to this technique, soldering on the outside of the rail is recommended.

## SOLDERING TIPS

There are several techniques for soldering, but all require that the parts be clean and that you apply flux (I prefer rosin paste flux). For most work I find a 40-watt iron sufficient.

I solder most of my parts by first tinning one piece, as that makes for a neat, quick joint. To tin a part, apply flux where you want solder (that is, where the two parts will be joined), then heat and flow solder over the area to get a thin, even coat.

To attach parts, flux the untinned piece, bring the parts together, and apply heat to the joint. Adding a little extra solder between the tip of the iron and the joint helps transfer heat and make a solid joint. I use .025"-diameter rosin-core solder for small work and .032"-diameter solder for larger pieces. — *Stephen Anderson*

## GLUE THEN SOLDER

I developed this technique to keep parts that are difficult to hold or clamp in position perfectly aligned while soldering.

I first glue the part in place with Duco cement from the top side. When the glue has dried, I turn the assembly over, flux the joint, heat the side and the deck, and apply solder to the joint until it flows and forms a fillet. When the soldering is complete, I remove the cement from the top side with acetone.

This method takes longer than simply clamping, so you don't want to use it for everything, but it's a life-saver for awkward pieces. — *Stephen Anderson*

# Changing the scale of drawings

Using a copy machine to make your modeling easier

Consider building models from plans. If the plans are in your scale you can just measure directly off them, but if you are working in a different scale, you must take a measurement off the plan, convert it to your scale, and then transfer the measurement to your work. The extra step gives you more chance for error, and it takes time.

Time was if you wanted plans converted from one scale to another, there would be considerable expense and a wait while a photographic lab did the enlarging or reducing. That has all changed, thanks to photocopiers that enlarge and reduce quite accurately. I can't guarantee that a particular copier is accurately calibrated; you'll have to experiment.

At this point I should remind you that the hobby magazines allow you to copy their plans for your own noncommercial use. This means you may not sell or give them to other people. Let your friends get their own plans and copies.

Whether you are using a machine at the local copy center or a home or office copier, you'll want to have certain tools with you. A scale rule in your scale is a must, and one in the same scale as the plans you're going to convert would be a good idea. The handiest rules have markings for all the scales on one. Have all your math figured out beforehand. In most cases the tables included in this article have done that for you. A calculator may be useful too.

## The scale conversion chart

Table A on the next page gives you enlargement and reduction figures for converting published drawings to your scale. Suppose you want an HO copy of an S scale plan. Find HO in the left column and follow it over to the S column. The reduction factor is 73 percent.

Let's take the relationship between N and O scales to demonstrate the theory behind these conversion ratios. Since the proportion of N scale is 1:160, you would have to line up 160 N scale boxcars end to end to equal the length of a full-size boxcar. Similarly, since O scale is 1:48, you would have to line up only 48 O scale boxcars to equal that same length.

We see, then, that there are 48 O scale units for every 160 N scale units. The ratio  $\frac{48}{160}$ , or .3, represents N compared to O. N is 30

percent the size of O scale. On the other hand, O compared to N is  $\frac{160}{48}$ , or 3.33. O scale is 333 percent the size of N scale.

To make a copy, first check the plan you are going to convert to be sure it is to scale. The hobby press tries to be accurate, but mistakes have happened. Also, paper can shrink or expand with changes in atmospheric conditions. Check the longest labeled dimension you can find on the plan with a scale rule. If you are satisfied that your plan is accurate, set the copier to the desired conversion and let it do its work.

If your plan is oversized or undersized, make adjustments by setting the copy machine a percent more or less than called for in Table A. The results should be close enough.

Similarly, if the copier is not calibrated accurately, try a percent or two different on the machine. This is why it's necessary to have your scale rule with you at the copier.

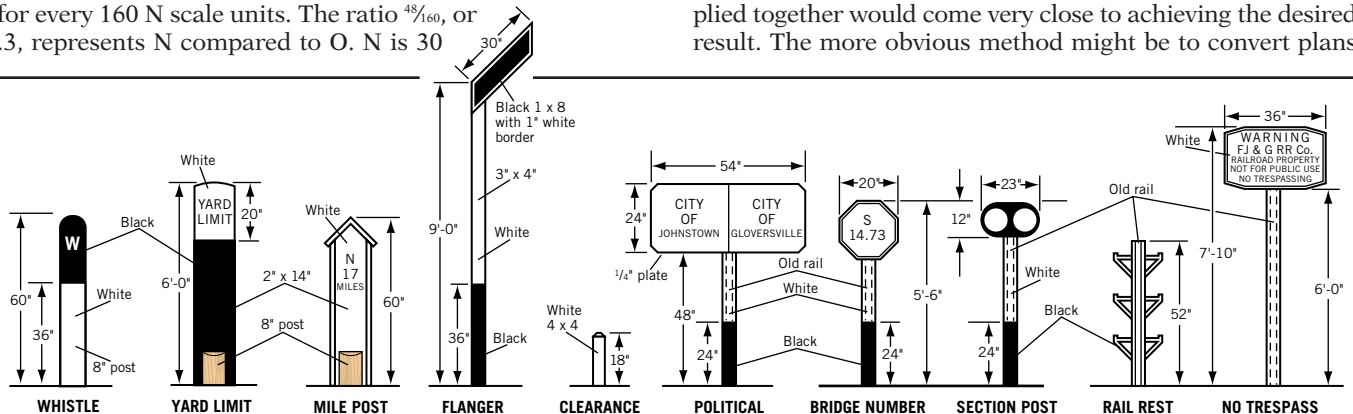
## Multiple step conversions

There's one shortcoming with Table A. Some of the conversion factors may not be within the capabilities of the copy machine you're using. The data in Table B is based on the capabilities of a Canon NP 7550 that could make copies between 64 and 142 percent of the original. Today you can readily find copiers that range between 50 and 200 percent. The percentages here still work, though you may not need to do multiple steps if you have a wider range available.

The Canon NP 7550 I used can't make the 30 percent reduction we need to get from O scale to N. We need to make a series of three conversions, as shown in Table B. We make a 67 percent reduction of the original, a 67 percent reduction of that copy, then a 67 percent reduction of that. It's a good idea to mark these copies as you make them so you won't lose your place.

I've limited Table B to conversions from S, O, and HO scales, since most model railroad drawings are published in these sizes. However, from each of these three scales you may convert to any of the other scales.

I arrived at the values in this chart by crunching numbers with a calculator to find whole numbers that when multiplied together would come very close to achieving the desired result. The more obvious method might be to convert plans





BY GEORGE A. EDWARD

from one scale to another. For example, to get from O scale to HO scale you could reduce from O to S (75 percent), and then reduce from S to HO (73 percent), and you should come very close. The problem here is that one or more of the ratios may be rounded off, so slight errors will be introduced. The numbers in Table B should produce more accurate results.

### From no particular scale

How about a plan that's published in a scale that isn't specified or isn't a popular model railroading scale? After quite a bit of mental exercise, I arrived at a method that does the trick. It's simply a matter of comparing the actual size of one scale foot on the plan to the actual size of one scale foot in your scale. Let's follow an example:

In the *Trainshed Cyclopedia No. 2* (published by Newton K. Gregg), I found a set of drawings for the USRA 2-6-6-2 Mallet. The publisher's goal was to fill the page nicely, with no thought given to scale. Let's call it X scale. A quick check with my scale rule told me that X scale was larger than HO, but smaller than S. I decided to convert the drawing to S scale, since it would need only a one-step conversion. All we have to do is to figure out how much to enlarge it.

Two long, labeled measurements were included on this drawing: total wheelbase (49'-9") and overall length (61'-11"). I measured the actual length of the overall length, which was 9<sup>13</sup>/<sub>32</sub>". At this point I converted both measurements to decimal form: 61<sup>11</sup>/<sub>2</sub> feet is 61.916667 feet; 9<sup>13</sup>/<sub>32</sub>" is 9.40625".

I determined the actual size of one scale foot on the drawing by dividing the actual length by the number of scale feet in it: 9.40625" divided by 61.916667 feet is .1519179" per foot.

Next I compared the size of one scale foot on the drawing with one S scale foot <sup>3</sup>/<sub>16</sub>" or .1875".

Since the drawing is smaller than S scale, we know we'll be enlarging, so the fraction must have the larger number in the numerator (top), and the smaller number in the denominator (bottom):  $.1875 / .1519179 = 1.23$ . We'll be making a 123 percent enlargement.

I made a copy, then checked to see how close I'd come. That's it; all of your favorite plans, in your favorite scale, are only as far away as the copier.

**TABLE A: SCALE CONVERSION RATIOS**

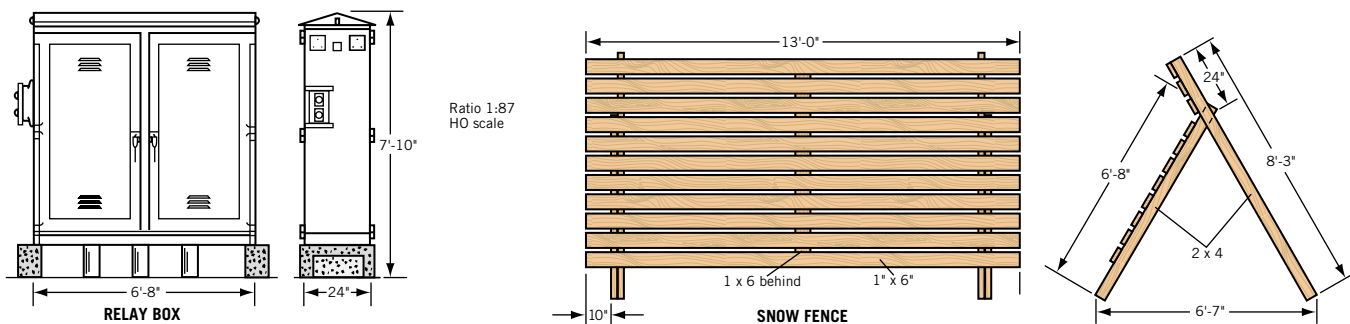
Desired drawing scale	Published drawing scale							
	No. 1 scale (1:32)	O scale (1:48)	S scale (1:64)	OO scale (1:76)	HO scale (1:87.1)	TT scale (1:120)	N scale (1:160)	Z scale (1:220)
No. 1 scale (1:32)		150%	200%	238%	272%	375%	500%	688%
O scale (1:48)	67%		133%	158%	181%	250%	333%	458%
S scale (1:64)	50%	75%		119%	136%	188%	250%	344%
OO scale (1:76)	42%	63%	84%		115%	158%	211%	289%
HO scale (1:87.1)	37%	55%	73%	87%		138%	184%	253%
TT scale (1:120)	27%	40%	53%	63%	73%		133%	183%
N scale (1:160)	20%	30%	40%	48%	54%	75%		138%
Z scale (1:220)	15%	22%	29%	35%	40%	55%	73%	

**TABLE B: COMMON & MULTIPLE STEP CONVERSIONS\***

CONVERSION DESIRED	PERCENT DESIRED (ROUNDED)	NUMBER OF STEPS	REDUCTION/ ENLARGEMENT SETTINGS
O to No.1	150	2	125; 120
O to S	75	1	75
O to OO	63	2	77; 82
O to HO	63	1	64
O to TT	55	2	68; 81
O to N	40	3	74; 74; 73
O to Z	40	2	64; 64
O to N	30	3	67; 67; 67
O to Z	22	4	69; 68; 68; 68
S to No.1	200	2	142; 141
S to O	133	1	133
S to OO	84	1	84
S to HO	73	1	73
S to TT	53	2	73; 73
S to N	40	3	74; 74; 73
S to N	40	2	64; 64
S to Z	29	3	67; 66; 66
HO to No. 1	272	3	142; 139; 138
HO to O	181	2	133; 136
HO to S	136	1	136
HO to OO	115	1	115
HO to TT	73	1	73
HO to N	54	2	68; 80
HO to Z	40	3	73; 73; 74
HO to Z	40	3	73; 74; 74

\*Based on Canon copier with reduction/enlargement capabilities of 64-142%

Below are HO scale drawings of common trackside items. Use the drawings as reference for building details for your layout.



# How to use a scale rule

## Tips for converting the scale of drawings

**O**kay, you've found that perfect structure in an article or prototype drawing in *MODEL RAILROADER*. The only problem is the plan is S scale and you're an N scaler. You could use a photocopier to quickly enlarge or reduce a published plan to your scale. Or you can use the drawing and convert dimensions from one scale to another using a scale rule.

Add an architect's scale and you can transfer dimensions from published layout plans to your own layout, or see if some neat feature on a layout will fit your space.

### Model railroad scale rule

You can get scale rules marked for only one modeling scale, but I suggest you purchase one marked with all the standard indoor modeling scales (N, HO, S, and O scale are commonly found on most rules). Most rules show the zero mark set in from the edge. Be sure to start your measurements from "0" – not the end.

Most published plans include prototype dimensions in feet and inches. Use the markings on the rule to transfer these dimensions directly to your model. Use the prototype dimensions and the scale of the drawing doesn't matter. I used the O scale rule to transfer measurements from an HO plan directly to a sheet of styrene (fig. 1).

If you know the scale of the drawing measure the plan directly with the appropriate scale markings (fig. 2), note the dimensions, and then mark that dimension in your scale with the rule (fig. 3).

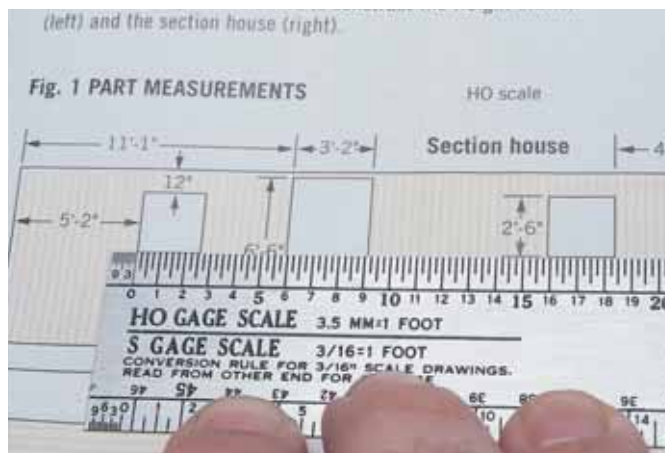
### Architect's scale

An architect's scale is another type of rule that's useful for model railroading. Architect's scales are available at most stationery or art supply stores. The scale is marked in a variety of standard drawing scales, including those we often use for track plans in MR.

When you're building a layout from a published plan, an architect's scale offers a simple way to transfer dimensions directly from the plan to the layout (fig. 4). Match the scale of the drawing to the scale on the rule. Then transfer the measurement to the layout.



**Fig. 1 TRANSFERRING DIMENSIONS.** After reading the prototype dimensions from an HO scale plan, use an O scale rule to draw the outline of a door onto styrene.



**Fig. 2 MEASURING SCALE PLANS.** Measure a window opening on an HO scale plan with the HO scale calibrations on the rule. The opening is 30" (or 2½ feet) wide.

## THINNING PAINT



Thinner: Formulated to spray, use AP-100 if necessary  
Spray pressure: 15 to 30 psi



Thinner: Floquil Airbrush  
Thinner, 75% color, 25% thinner  
Spray pressure: 12 to 20 psi



Thinner: Scalecoat thinner,  
50% color, 50% thinner  
Spray pressure: 10 to 20 psi



Thinner: Scalecoat II thinner,  
50% color, 50% thinner  
Spray pressure: 15 to 20 psi

← SOLVENT-BASED  
WATER-BASED →

BY MARTY MCGUIRK



**Fig. 3 CHANGING SCALES.** To enlarge the window opening on the HO plan to O scale, flip the rule to O scale and measure the 30". Be sure to measure from zero, not from the end of the rule.



**Fig. 4 USING AN ARCHITECT'S SCALE.** An architect's ruler is handy for measuring published track plans. In this case the scale of the drawing is  $\frac{3}{4}$ " to the foot.

## STORING MODELS

I like to use the original boxes models come in for storage, but I've had problems getting my Bachmann Spectrum models in and out of the boxes because of the tight fit. I solved this problem by discarding their original paper wrappers and replacing them with plastic bags.

I've found the gallon size of the cheapest twist-tie plastic bags you can buy works best. These inexpensive bags are thin, very soft, pliable, and extremely slippery. I use a long, sharp knife to slice the bag open so I have a large, flat piece. I trim it down so the plastic is about 3" larger than the model all the way around. The slick plastic bag lets the models slip easily into the box insert. Removing the models is accomplished by grasping the plastic film at the tops and bottoms and pulling it straight out.

I wrap brass models in the plastic from whole bags and slip them into the original foam-lined boxes. This keeps the foam from "melting" onto the model and also facilitates its damage-free removal from the box.

For models in unlined boxes, like the ones from Athearn and Model Die Casting kits, I use the gallon bags without cutting them open. I slip one model into the center of the bag and roll it up to protect the sides from abrasion. Lay the model in the box and then bunch up the extra bag material at each end to keep the car from sliding around. Long cars and locomotives get two bags, which I slide on from each end, then bunch up along the sides and ends for protection. – *Lew Matt*

## STORING LOCOMOTIVES

Storing engines isn't much different than storing any other rolling stock. However, you do need to take pains in packing them so parts like the side railings on road switchers are kept in their normal alignment and aren't bent out of position by the packaging.

There isn't much else to worry about except to keep the equipment in a cool, dry place (not in the attic as the heat in summer will distort the plastic bodies). A bedroom closet is a good choice.

Slight oxidation is bound to occur over time on the wheel treads and motor commutators. Returning the locomotives to service is a matter of simply polishing off the oxidation, cleaning out the old lubricant, then relubricating the gearboxes. A tiny drop of contact cleaner on the electrical pickup points also helps get those wheels turning again.

I've resurrected O and S tinsplate trains and HO and N scale models that have been stored up to ten years in this manner without difficulty. – *Jim Hediger*

## STORING STRUCTURES

When the Kalmbach employees' club was faced with moving a lot of fragile structure models for its new Milwaukee, Racine & Troy layout, members slipped each structure into an individual plastic bag. The bags were then carefully boxed up using lots of lightweight Styrofoam plastic pellets to separate and cushion things.

The bags kept everything dry and contained any parts which might fall off and get lost. Some of the buildings were stored in this manner in a cool, dry location for a number of years. As they're unpacked, there's no evidence of any ill effects. – *Jim Hediger*



Thinner: distilled water (if needed)  
Spray pressure: 30 to 35 psi



Thinner: denatured alcohol  
50% color, 50% thinner  
Spray pressure: 25 to 30 psi



Thinner: Polly S airbrush thinner  
80% color, 20% thinner  
Spray pressure: 20 to 25 psi

# Step-by-step diesel locomotive tune-up

## Easy tricks to improve performance

The first trip of a new locomotive is something model railroaders look forward to with great anticipation. Our imaginations run wild with visions of a prototype's smooth start as the new model leans into the couplers and begins to pull.

Most current diesels are sold ready to run, but a little tuning up can make a big difference in performance. Older models will also benefit from an occasional tune-up. The model shown here is an HO Athearn GP60, which has one of the hobby's most popular mechanisms.

### Inspection

The first step is to remove the body. Most diesel mechanisms have cast lugs which fit into openings on either side of the body shell. If the sides are spread slightly, the chassis will drop free. Recent Athearn models have clips which pass through slots in the bottom of the fuel tank. Grip the fuel tank in one hand and gently rock the body slightly from side to side to release the chassis as shown in fig. 1.

Set the mechanism on the track and observe how it operates. A stuttering motion is symptomatic of problems caused by dirty wheels, corroded contacts, or frayed wiring. If there's slow-speed hesitation, look for binding in the mechanical parts. If a truck doesn't sit level, parts may not be fully seated.

### Wheel cleaning

Poor electrical contact affects performance more than any other single factor; dirt is usually the culprit. Attach test leads to the motor connections and hold the frame upside down in your hand. Turn on the power so the engine runs, then use an abrasive block to polish the wheel treads to a shiny surface.

Never use steel wool for any of this cleaning as small shards of metal break off and can cause a short circuit.

### Mechanical checks

Slow-speed hesitation requires disassembly of the trucks to check the gears. Work on a clean bench and take one truck apart at a time. With a small screwdriver pry off the retainer

**Fig. 1 REMOVING BODY.** Look for side lugs or clips to determine how to remove the body.



**Fig. 2 REMOVING WORM HOUSING.** Use a small screwdriver to gently pry off the combination worm housing and truck retainer.

that holds the worm assembly on top of the truck (fig. 2). Note how the universal joints fit together as you remove the truck. With the truck off, polish the electrical contact surfaces around the kingpin on the truck and underframe (fig. 3).

Spin the truck wheels with your finger. If the gears turn smoothly don't open the gearbox. If there's a bind, pop off the retaining clip and open the gearbox, fig. 4. Inspect the gear edges and hubs for flash, chips, or dirt. Lay the gears down in order and check inside the gearbox castings. Remove stray material, then wash the parts with detergent and warm water.

With the truck apart, check wheel spacing with a National Model Railroad Association standards gauge, fig. 5. Adjust by gripping both wheels in your fingers and twisting them in or out of the molded gear. Check the axle gears for flash or dirt.

### Lubrication

Very small amounts of lubrication will do the job on model locomotives. One small drop of plastic-compatible light oil will suffice on the bearings (I use Labelle no. 108). Don't add any further oil unless something squeaks.

Reassemble the truck and add a drop or two of model grease to lubricate the gears. See fig. 6. Each gear's teeth should be covered with a thin film of grease, but you don't want it to spread. Labelle no. 102 grease is my choice. Make sure you use the right type as some lubricants attack plastic.

### Electrical pickup

A good electrical path from the rails to the motor is essential. Clean and check every contact point where current is transferred between components. Some models have tiny phosphor bronze fingers which rub against the wheels to pick up current. Remove any lint trapped in these pickups, and adjust their tension for good contact.

Look for frayed wiring or loose connections. Replace defective wiring with flexible wire, but be careful soldering so you don't damage nearby plastic parts.

Athearn models come with a steel contact strap that I replace with flexible wire, fig. 7, to improve the electrical path. To do this, remove the steel strap and cut off the truck extensions about 1/4" beyond the motor clips. Solder a piece of

BY JIM HEDIGER



**Fig. 3 TRUCK KINGPIN.** Polish all electrical contact points where current is transferred between mechanical components.



**Fig. 4 GEARBOX.** Be sure to clean off any molding flash (excess plastic) or dirt that you find in the gearbox.



**Fig. 5 GAUGING WHEELS.** Use an NMRA standards gauge to check the spacing of all the wheelsets and correct any problems.

flexible wire to the top center of the strap and add a short piece of wire to one end for the headlight connection. Snap the shortened strap on top of the motor, bend the wires around to reach the trucks, and then solder one end to each truck bracket. Finally, shorten the headlight contact and solder the short wire to it.

### Final inspection

Reassemble the chassis, test-run it, then wash your hands so you don't fingerprint the body with lubricants. Repair any body damage, replace missing details, touch-up nicked paint, and adjust couplers. It takes only a few minutes to tune up a locomotive, but it makes a world of difference.

## LUBRICANTS

Lubricating model trains with ordinary household oils is risky as many of these include chemicals that attack or soften paint and plastics. Your best bet is getting plastic-compatible lubricants from a hobby dealer and using them sparingly.

Many manufacturers provide instruction sheets that include lubrication diagrams and intervals. Take a few minutes to read them over and see what they recommend.

The critical lubrication points in most locomotives are the worms and axle gears. Worm gears tend to be metal, while the axle gears are usually engineering plastic. If they run dry, the pressure of the worm will usually cut into the axle gear and destroy it. Apply just enough grease to coat all the teeth.

Too much oil on the front motor bearing invariably finds its way onto the commutator. The light oil temporarily helps the motor brushes obtain better electrical contact. However, as the volatile components burn off, a thick, gunky residue remains to ruin electrical contact.

Get a spray can of TV tuner cleaner from an electronics shop. Remove the locomotive body and spray a little into the commutator area of the motor. Let it stand for a minute or two. Use a paper towel and cotton swabs to wipe up the dirty cleaner and give it five or ten minutes to evaporate. Then test-run the model; it should show marked improvement. Sometimes it takes a couple of treatments.

As for oiling, I follow the "squeaky wheel" rule and only add a tiny drop to silence the noisy item. Excessive lubrication is thrown off inside the shell where it may damage paint.

Car trucks seldom need lubrication except for the all-metal ones in S, O, and G scales. HO and N scale trucks usually have needlepoint bearings in acetal plastic sideframes. If lubrication is necessary, a puff of powdered Teflon will do the job. Adding oil may soften the plastic and increase drag.

As a former train repairman, I found most model trains suffer from too much lubricant rather than not enough. A little lubricant goes a long way. — Jim Hediger



**Fig. 6 LUBRICATION.** Apply only a couple drops of plastic-compatible lubrication in each truck gearbox.



**Fig. 7 NEW WIRING.** Replace the original Athearn steel contact strap with flexible wires soldered in place for a more reliable electrical path.

# Tools for scratchbuilding in brass

What you'll need to work with this metal

BY STEPHEN ANDERSON

**W**hen working with brass you'll be measuring, marking, cutting, drilling, filing, and soldering. These require just a very small collection of tools. Most of the tools needed to construct a brass engine are shown in the photos.

## Basic necessities

- The most useful tool that I have found is a dial caliper because it shows, on an easy to-read dial, the exact size to .001". A caliper of adequate quality costs about \$30. Don't buy a plastic one as you'll be using it as a scribe as well as a measuring device.

- For laying out parts you'll also need a center punch, a small machinist's square, and a scribe, and don't use your scribe as a center punch – you want the tip sharp.

- Good cutting tools make your work easier and better. A razor saw works fine for cutting brass, but it's rather slow. Not pictured is a jeweler's saw, which is shaped like a small coping saw; it allows you to cut curves and complex shapes.

- You'll use files more than any other tool, so they should be the best quality you can find. For heavy cutting, you should have an 8" and a 6" mill file. Try to get these from a store that sells to industrial customers. They will cost a little more, but better files make the work go faster and easier.

- A set of jeweler's files is necessary for finishing small parts, the smaller the file the better. A set from Radio Shack is a good start, but try to get one high-quality square jeweler's file. High-quality files have smaller teeth and remain sharper longer. A set of very small jeweler's files is also handy. None of these files are very expensive, but they are cutting tools and should be replaced when they become dull.

- You'll need a set of small numbered drills and a pin vise. I use 00-90, 0-80, and 2-56. One tap for each of the screw sizes is also needed. Using a pin vise to drill holes gets old after a short time. I suggest getting a small precision power drill such as a Dremel Moto-Tool or hand unit.

- A 40-watt iron is adequate for almost all soldering. I use paste flux to clean the metal first. I recommend .025"- or .032"-diameter rosin-core solder. It may be helpful to have a 250-watt soldering gun, but I seldom use the one I have.

## Additional options

If your budget allows, you may want to add some tools to make your work faster and easier.

- A drill press is almost a necessity. A drill press stand for your motor tool will do. Next I recommend a speed control for your motor tool. I made mine from a foot-operated sewing machine speed control which leaves both hands free.

- The tool that saves the most time and aggravation is a powered bench-type scroll saw. I use one to cut brass sheet and rod. It reduces an hour-long cutting job to about a minute.

- A small lathe such as a Preac, Sherline, or Unimat is a good investment, especially if you want to build cylinders, domes, and other complex parts.

## SQUARING AND CUTTING SHEET METAL

- To square brass sheet, file one edge perfectly straight with a 6" or 8" file. Don't assume the factory edge is straight!

Now coat the piece with machinist's dye – this allows you to scribe lines as easily as using a pencil. Using a small machinist's square, scribe a line very close to one end and perpendicular to the edge you filed straight. Now file the end to this line using your 8" file. You now have two edges that are straight and perpendicular to one another. From these, you can make accurate measurements to locate holes or lay out the shape of the part you're making.

- Cutting heavy stock, .032" and above, is best done with a saw (razor, jeweler's, or powered fret). Use a disk cutter in a motor tool for cutting bar stock to length and to cut sheet metal, but always wear eye and face protection: Disks break easily and flying pieces can cause serious injury.

For thinner stock, rough-cut the piece with metal shears (or scissors) by gradually cutting small slivers off each edge. This method ensures the sheet metal doesn't curl or distort.

Finish shaping the part with files. Use an 8" file for straight edges and jeweler's files for curves and final finish.

– Stephen Anderson

