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Building a metal tank car
Most modelers have their favorite medium in which to build. For many, it’s wood; for others, styrene. For some, though, the material of choice is metal. I am not one of those people. I’m far more comfortable working in wood or styrene. But in model building, working with metal is an unavoidable eventuality. Fortunately, it’s not really all that different from working with other materials, and metal does things other materials are simply incapable of doing. Strength is the main reason for this. That’s why many commercial locomotives and cars have metal handrails and other details instead of plastic. They don’t break off with everyday use. Metal is heavy. You can build a flat car out of wood or plastic and it may be too light to reliably stay on the track. If you build the same car out of metal, it’s going to have weight.

Still, for many modelers, building with metal is a daunting proposition. There’s a lot to learn about metalworking, from selecting the right metal for the job to fabricating and finishing. But we really limit ourselves if we shy away from this important and versatile medium.

Terminology
Let’s first look at some terms that will come in handy when dealing with metal.

Annealing is heating, then cooling certain metals (especially brass and copper) to make them softer and more workable. Typically, this requires heating the metal until it glows a dull red, then letting it cool. Once cool, the metal can be bent and shaped much more easily.

An alloy is a blend of basic metals to form new metals with different properties. Brass is an alloy of copper and zinc.

Metal comes in a variety of shapes, sizes, and colors, and all can be used to build models of almost anything imaginable. Knowing which metal is right for the job, and how to work with it, will form the foundation of a vast array of modeling skills that will make your railroad a unique reflection of you.

Stainless steel is an alloy of steel, chromium, and nickel or other metals.

A brake (or bending brake) is a large tool used to make long, even folds in sheet metal.

A center punch is a sharp, pointed tool used to mark a single point in a piece of metal. It makes a small indentation so that, when drilled, the drill will put the hole precisely where desired.

A die is a tool used to cut screw threads onto a rod so that it can be screwed into a nut or other threaded hole. It’s also the name of a tool used to
form sheet metal into various shapes, used in conjunction with a press.

Gauge is a numerical value associated with the thickness of sheet metal or diameter of a wire. The higher the number, the smaller the thickness of the material.

Hardness refers to the stiffness of a metal. If a metal is described as being “hard,” that means it’s very rigid and won’t bend or cut easily. Conversely, a “soft” metal will bend easily. Certain “hard” metals can be made “soft” by annealing (see above).

A punch (in conjunction with a die) is used to put holes in sheet metal. The punch is the same shape as the die beneath, and cuts the metal out in that shape, similar to a hole punch for paper. See also stamp.

A scratch awl is a sharp, pointed tool used to mark a line on a sheet of metal where it will either be bent or cut (also called a scribe).

A shear is a cutting device similar to a paper cutter, used to make long, straight cuts in sheet metal. A paper cutter can be used for some softer, thinner metals, such as brass, copper, or aluminum.

A stamp is used to shape metal into complex shapes by sandwiching the material between the stamp and die. Both tools have matching shapes (one positive and one negative), and the metal, when sandwiched between them under pressure, takes on that shape as well. Many automotive panels and other parts are made on stamp machines.

Solder is metallic alloy used to join two pieces of metal. Solder is melted into the joint, then allowed to cool.

A tap is used to cut screw threads into a hole, so that a screw can be inserted.

Tin snips are heavy-duty scissors used to cut thinner sheets of sheet metal by hand.

Work hardening is the hardening or stiffening of annealed metal through working (i.e., bending, hammering, or other forming). Work-hardened metal can be reannealed to soften it again.

Materials

Let’s begin by looking at the various metals common to model building. Brass is the material most often used for models. It’s workable, relatively strong, and is easily soldered. Most hobby shops carry an assortment of brass rod, sheet, and shapes. Copper and tin are close cousins to brass, largely due to the fact that they’re present in varying degrees in different brass alloys. Their working properties are similar, though they’re softer than brass. Brass is also commonly used in casting detail parts. These parts are quite strong, and can be soldered to a model for added durability.

Other metals you will encounter include steel, aluminum, and “white metal,” which includes any of a variety of low-melting-temperature alloys used in casting detail parts.

Steel is known for its strength and is available in varying degrees of hardness. You can get mild-steel wire or strips from the local hardware store, while the “music wire” found in hobby shops is a very hard steel. I usually use mild-steel wire for things like handrails, since the wire can be bent with relative ease, yet is still robust enough to withstand handling. Many builders use steel for locomotive frames and other key structural elements where strength and durability is of primary importance.

Aluminum, on the other hand, hasn’t made large inroads into the model-railroading scene. You can get aluminum sheets, pipes, rods, and other shapes at the hobby shop, but aluminum’s relative
weakness and, more importantly, its inability to be soldered renders it a second-class citizen on many workbenches. Aluminum can also have an adverse reaction with other metals called electrolysis. This is a molecular reaction that will actually corrode the area where the two metals touch. For that reason, it’s best to use stainless-steel screws when working in conjunction with aluminum.

White metal is commonly used for detail parts for our models. It’s inexpensive and easy to cast. It’s not as robust as brass, but is strong enough to handle normal, everyday handling. It will melt at a fairly low temperature, so it must be glued or mechanically fastened to a model, as you cannot solder it.

Tools
The tools you’ll need for working in metal perform one of three basic functions: cutting, bending, or joining. Cutting tools include the aforementioned tin snips and shears, as well as wire cutters, metal-cutting saw blades, and cut-off disks for your motorized rotary hand tool. Tin snips work well for cutting thinner sheets of metal (.020" or thinner) by hand. For really thin stock (.005" or less—often called “shim stock”) a pair of common scissors works well. Wire cutters are good for cutting small strips and thin wires.

When you get into larger sizes of metal, where hand power is no longer sufficient, you’ll need to call in the bigger guns. A hacksaw or a metal-cutting blade on a bandsaw is ideal for cutting thicker pieces of metal stock. A cut-off disk in a rotary tool will make quick and even work when cutting through special shapes, where you don’t want to bend the piece as you cut it.

Also included in “cutting” tools would be drill bits and files. The operative word with any metal-cutting tool is “sharp.” Once it gets dull, it’s worthless. To prolong the life of your tools, remember that working with metal requires very slow cutting speeds. Make sure your power tools have speed controls on them and set them for speeds on the slower end of the spectrum.

“Bending” tools include pliers, hammers, and vices—tools that are used to physically bend the metal. There is a wide variety of specialized pliers to help bend metal, such as those that bend round corners or 90° angles.

Joining metals
When it comes to joining metals, there are two basic options—mechanical fasteners, such as screws and rivets, or soldering. Screws and rivets are certainly expedient, but not always practical or desirable. Soldering provides a strong, permanent joint without mechanical fasteners getting in the way. Soldering requires three things: a heat source, be it from a torch or iron; solder; and flux, a compound that cleans the metal, allowing the solder to flow into the joint.

Next time, we’ll take the tools and materials discussed here and use them to build a small tank for a water car.
In the realm of building materials, metal may seem the most daunting. It’s the most difficult to cut, shape, and join. For that reason, many modelers shy away from using it. Yet, for all its difficulties, it’s also one of the most versatile materials to work with. So, why do we fear this material and use it only as a last resort? I think the root of the problem comes down to one word: “solder.”

Perhaps our first attempts at soldering were so disastrous that we decided it was no fun and we never tried it again. Whatever the reason, our fear of this ultimate “hot-melt glue” keeps many of us from using a really fine building material.

I’m going to introduce you to the world of metalworking, including the dark art of soldering. As my subject, I’m going to build a small tank car for our work train. I’ll start by selecting the materials from which to build the tank, then I’ll show you the steps involved in shaping and soldering it up.

To start, I need to decide how large the tank should be. To keep things simple, I’m going to use the four-wheel flat car we built in the October 2005 issue of GR as a base. That means the tank will have to be fairly small. A stroll through the plumbing section at the local home-improvement store turned up some 2”-diameter copper pipe caps.

Brass tacks (and other metal bits), part 2

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which will work beautifully for the tank ends. The same aisle offered a \( \frac{3}{4} \)" pipe cap for the dome. Unfortunately, pipe caps fit outside the standard 2" copper pipe, so that pipe won’t work for the body of the tank. I’ll have to bend my own from a sheet of brass—an excuse to stop by the hobby shop.

Since I’m going to bend the brass by hand, I don’t want a sheet that’s too thick, but I don’t want it to be too thin, either. It’s got to be fairly strong, so I can attach details to it later. I found some .016" brass sheet that was 4" wide x 12" long that will work nicely.

I want to model a tank that was riveted together, so I need to emboss rivets into this sheet of brass before I roll it to form the tank. To locate the rivets, I draw a line \( \frac{1}{8} \)" in from the edge of the brass, then make cross-marks every \( \frac{1}{4} \)" (photos 1, 2). The spacing can vary as you wish. To make the rivets, I place the brass sheet over a piece of oak, which provides a firm cushion into which the punch will press the rivets. If the surface is too hard, the rivets will flatten, if they raise up at all; too soft, and they’ll look like pimples instead of rivets. I used a spring loaded, automatic center punch, so all I needed to do was press down (photo 3). A hammer and a sharp punch will work just as well, but you should strike the punch as evenly as possible. You can also use any number of commercially available rivet-embossing tools, but they’re not necessary.

I wanted a ring of rivets to run around the dome, so I marked the center of the sheet, traced the outline of the dome base, and marked rivets there as well.

With the rivets embossed, it was time
to bend the brass sheet. The brass has some spring to it, so I had to bend it around an object smaller than the diameter of the actual tank. I used some scrap plastic tubing I had lying around (photo 4), but a shovel handle would work equally well. When you bend the brass, the very ends will not bend as much as the rest of the sheet. Those ends can be bent in slightly with a pair of pliers once everything is ready to solder. Once the sheet is mostly bent, I cut off the excess, leaving a ¼" overlap (photos 5, 6).

Then it was time to solder. The key to soldering is to make sure mating surfaces are clean. Sand them with sandpaper and/or steel wool (photo 7), and your work will be much easier. Once things were clean, I prepared the pieces to be soldered together. Because the brass wrapper wanted to relax to a diameter slightly larger than the tank ends, I held it in place with steel wire (photo 8). The steel wire wasn’t been cleaned, so the solder shouldn’t stick to it.

There is a lot of metal here, so a large heat source is necessary so the solder will flow evenly. A plumber’s torch works well. I applied a bit of flux (a cleaning agent that helps solder flow smoothly) to the joint, and began heating the copper end caps. Always apply the heat to the more massive of the two parts being joined—here, the end cap—letting it heat the part with less mass. The brass sheet formed a natural lip against the copper cap, so I used that to my advantage. I heat the copper to the point where the solder just started to flow when touched to the copper. I touch the end of the solder just above the joint and let capillary action draw the solder into the joint (photo 9). Solder flows toward the heat, so both parts of the joint need to be good and hot.

Once the ends were soldered, I ran a bead of solder along the bottom seam of the tank. (If you’re new at this, get a bunch of cheap copper fittings from the hardware store and practice until you get the hang of it.)

With the main tank soldered, I was ready to prepare the dome. The first thing I needed to do was shape the base of the dome so it fits on the tank. I started with a half-round file to rough out the curve, then finish up by wrapping some 60-grit sandpaper around the body of the tank and rubbing the base of the dome on it to get the final fit (photo 10). I then cleaned the top of the tank where the dome will be attached, so the solder would flow smoothly there, applied heat to the dome, and gently applied the solder. A small screwdriver can sometimes help the solder to flow (photo 11). Be careful not to apply too much solder, as you don’t want to obscure the rivets punched around the dome’s base.
With the dome firmly attached, it was time to clean things up and remove all those little excess blobs of solder (photo 12). I started by cleaning the tank with soap and water to remove the flux residue, then I went over it with some steel wool. This highlighted the blobs that need removing (photo 14). Next, using files, my Dremel tool (photo 15), and sandpaper, I filed down the blobs until they were smooth. I use progressively finer sand paper until the metal was smooth again. The neater you are at soldering, the less of this you’ll have to do, but there is always going to be some clean-up with soldering.

The basic tank was now ready to go (photo 15). Next time, I’ll add details and discuss how to solder them in place using smaller, more precise soldering tools. I’ll also address drilling, tapping, and other metalworking techniques to complete the small tank car.
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