Married Metals Process Overview

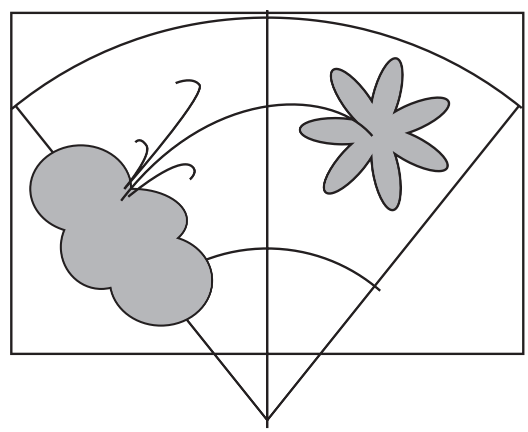
Brian Meek ©2007 V1.5

Goal

To introduce the student to one technique (out of several) for producing 'married metals' pieces. As the class seems interested in doing several different types of finished objects, this handout will discuss general techniques and concepts applicable to all married metal work, rather than focusing on the specific step-by-step process to produce a specific piece.

Tools & Supplies Needed

- 2 x 3" piece of 20 ga Sterling silver
- 2 x 3" piece of 18 gage copper or new gold
- 3/0 saw blades, #6 saw blades
- Some end piece in mind.

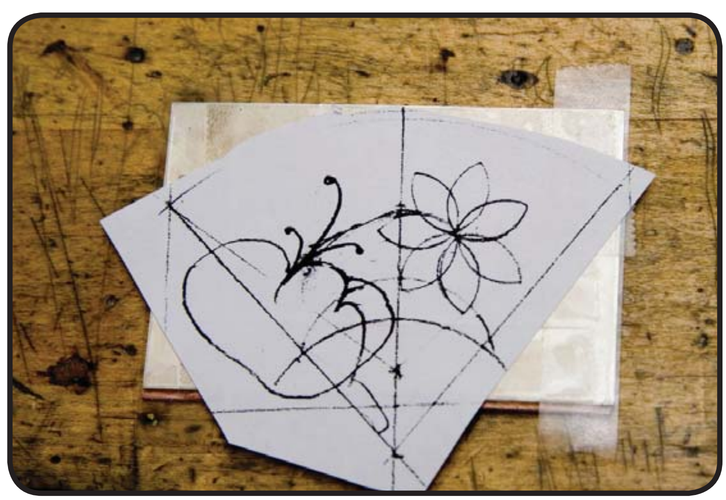


Basic design for the fan brooch.
Trace onto tracing paper, and attach to your metal.

Background

"Married Metals" refers to a series of techniques that produce a single sheet of metal that appears to be composed of several different types of metal, usually arranged in some sort of deliberate pattern. This effect can be achieved by a variety of techniques. The contrasting metals can be soldered onto the top of a parent sheet, then crushed into it with a rolling mill. or the sheet can be soldered together out of individually cut and fit sections of different metals. The technique we will be using is a hybrid of several other 'married metals' techniques. We will saw out our main designs from two (or more) sheets of metal riveted together–to preserve alignment. We will then exploit the plastic properties of our metal to allow us to close the gap left by the saw kerf as we cut through. From there, we solder the inserts into place, solder whatever linear elements we want into place, and then proceed to clean up the sheet and make something interesting out of it.

The example piece that will be used is a Japanese fan design as a pendant. Feel free to experiment with whatever design you like.



Design, xeroxed and taped onto metal surface with double-sided tape.

Procedure

Step One:

Come up with a design. Married metals is not a technique that lends itself to 'winging it'. Before you do anything, it's best to have a firm notion of what you intend to make, how big it'll be, and how you'll put it all together. The reasons for this are several.

The first reason is that you have to produce the sheet metal for your project. Which means you need to know how much you need to make, and roughly what shape it need to be, both to save wasted effort, and to make sure whatever design you put into the metal fits the scale of your finished piece.

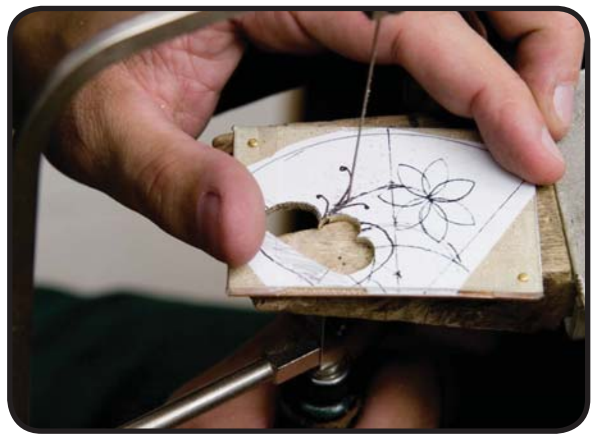
Another reason is that the finished 'married' metal sheet is not horribly strong. It has many solder joints in it. This means it will be prone to cracking along the joints if you try to deform it greatly, or if you overheat it even just a little while performing follow-on soldering operations. Which means you have to think about how you plan to put it together, and how far away from a flat sheet you plan on taking it. This is not to say that you can't solder it, or that you can't form it. You can, you just have to think about it first, and plan carefully.

The third reason is that you have to trap your design. The key to this version of the technique is that we will be stretching the metal of the inserts slightly to force them to fit into the hole cut through the parent sheet. This means that the inserts must be surrounded on all sides (or trapped) within the parent sheet, otherwise the technique won't work.

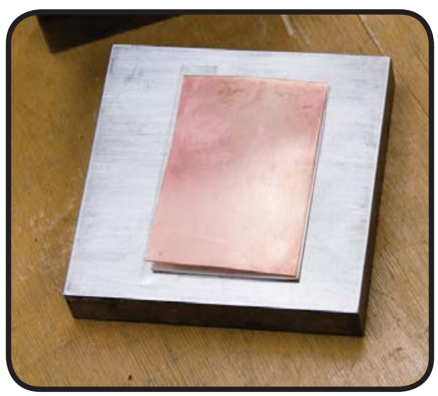
The 'flower' design I used for the fan has several important design elements that bear pointing out.

- Both of the big inserted areas (the flower and the ground) are 'trapped' within the parent metal. They don't touch the outer edge anywhere.
- The 'ground' element extended beyond the area I intended to use: this let me drill into the sheet in an area that would be cut off later, thus avoiding having to deal with the hole.
- The two main elements were connected, so that I could saw out the 'ground' by starting at the drill hole, and then saw along the 'stalk' to get to the flower without having to drill another hole anywhere.

Hole drilled for piercing. Note that it's beyond the area of the fan that I'm planning to use, but that the 'ground' is still completely trapped within the parent sheet.



Sawing from the 'ground' over to the flower with a #6 sawblade.



The metal sandwich on a steel surface block, prior to being flattened in the press

Flattening it in the press...

Step Two:

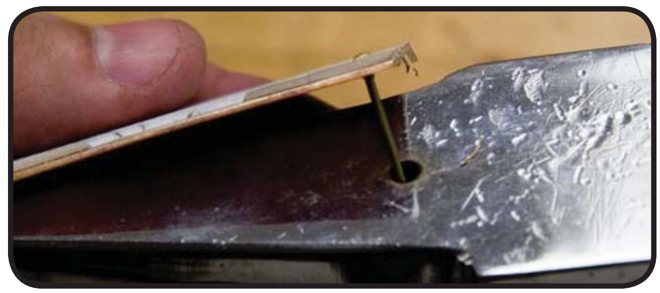
Rivet. This is pretty simple: we just need some way to hold the two sheets together while we saw out the design. The first step in this process is to stick the two sheets of metal (the silver and your contrast metal) together with double sided tape. Lay out the tape so that the entire surface of the silver is covered. Make sure there are no overlaps in the tape, or the increased thickness will cause problems later.

The annealed contrast metal will not be flat. Be not concerned. Our next step is to flatten the whole mess. Go out back to the hydraulic press. There should be two steel surface blocks out there. Find the best (non-marked) surface on one of the plates. Set your silver (tape side up) onto the middle of it. Set the warped piece of contrast metal on top of that. Make sure it sits evenly on the silver, so that once it's flat, it'll line up properly with the silver. Place the other steel surface block on top of the metal sandwich, and place them into the hydraulic press. Pump it up to about 4000 on the gage. Once you release it, the metal should be flat, as well as firmly smashed onto the double sided tape. Don't worry if it's not perfectly flat, it'll probably be close enough.

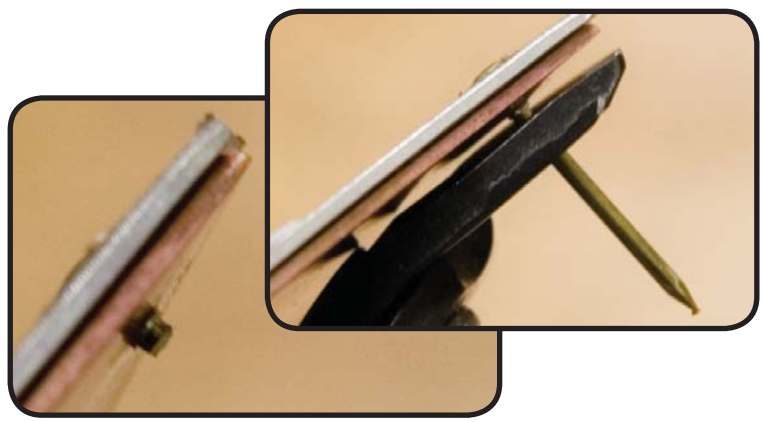
To rivet the piece together, there are some .050" diameter brass nails on my desk. There should be a #56 (.046") drill already in the drill press. Center punch two holes at diagonally opposite corners of the metal sheets, outside the area you intend to use. Drill them, and then gently tap the nails through the holes. The drill is slightly undersized, so the fit will be tight. The nails are tapered, so they will go through. Make sure you tap them through such that the nails pass into the hole in the jeweler's anvil on my desk.

Once the rivets are in place, trim the ends off with the orange flush cutters. Leave 1-2mm of rivet standing above the surface. Set the rivet gently with a riveting hammer. These rivets only have to hold for a few hours, so they don't need to be anything fancy.

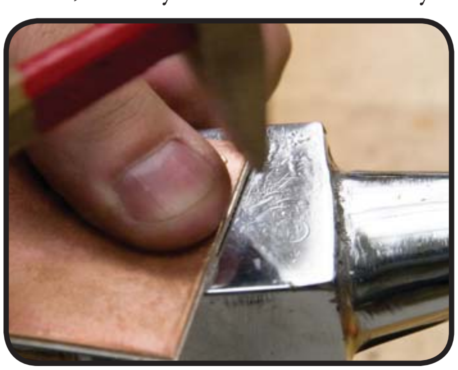
Getting set to drive the nail through the drilled hole. There is a hole in the anvil underneath where the nail is. Make sure you drive the nail into that hole. You will not be able to drive a brass nail into a steel anvil otherwise.



The nail's been drive through. Note the hole in the anvil.



Trimming the nail into a rivet. Leave just about 1mm above the lower surface of the metal



3 views of setting the rivet. It doesn't have to be fancy.

Step Three:

Pierce your design. Once you've got your sheets riveted together, it's time to cut them. Take a copy of your design, and stick it to the surface of your silver with double-sided tape. Make sure you cover the whole surface without overlaps. Find an area within one of your contrasting areas that will be cut off in the final piece. Drill a whole there to allow you to get the saw blade in.

Thread your sawblade (with a 3/0 blade) through the hole, and begin to saw out the first insert.

There are several things that are critical in this sawing. Strangely, accuracy isn't really one of them. (for once.)

The things that are critical:

- Your hand must hold the saw vertical as you saw. Any fore-and-aft, or side-to-side tilts will cause problems with how the inserts fit.
- Accuracy may not matter here, but smoothness does. We can make any shape fit, but there's no way to correct a wobbly sawn line. Thus it is vastly more important that your sawn shapes be smooth and even. Nevermind if they're not exactly following your drawings. Come back to the line gently, don't zig-zag trying to stay on the line. Be gentle and smooth.

Step Four:

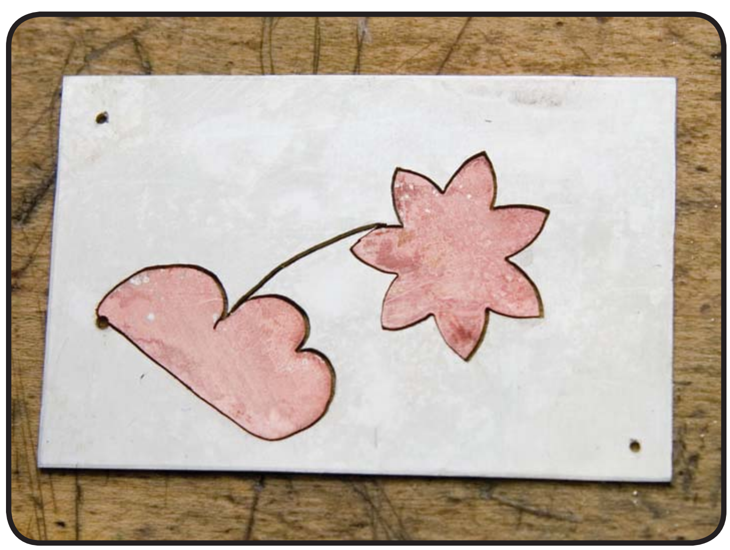
Planish the inserts. Once all of the areas to be inserted have been pierced out, the next step is to separate the two pieces of parent metal, and then to planish the inserts into place.

First, separate the two pieces of parent metal. If you just used double-sided tape, slide a knife blade in between the two sheets, and use it to pry them apart. If you riveted the two sheets together, the easiest way to remove the rivet is to simply saw away the corners of the parent sheets that contained the rivets. Put the rivets out on the edges, and your loss will be minimal. The rivet holes should have been beyond the area of parent sheet you were intending to use, so there's no loss to the design either.

Separate the two sheets of parent metal. Then separate the two pieces of each insert. Take the inserts that compliment the parent sheet you intend to use as your main background, and go out back to the anvils.

Threading sheet metal onto saw. Note that the metal is all the way up against the forward blade clamp. This will support it, and leave you with two hands to fasten the blade.

3/0 and #6 saw blades. .011" and .0185" respectively. The different thicknesses of sawblade will give you different line weights of inlay color. Important idea to remember.



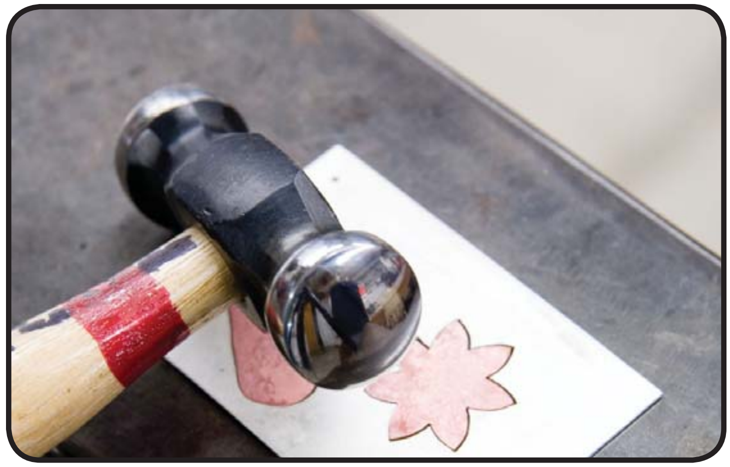
The parent metal with the rivets removed, and the two inserts placed in from the back. Note the saw kerf around each insert that makes the insert too small to fit.

Select a planishing hammer. These are the small hammers with one flat face, and one slightly domed face. Select the hammer with the best polish on the domed face.

The planishing comes next. The idea behind it is simple: metal is actually play-doh with an attitude. When we cut the inserts out of the parent metal, the sawblade cut a thin track the width of the blade through the metal sheets. This gap, cut by the saw, is called a 'kerf'. It's of no great import normally. In this particular instance though, the kerf makes the inserts slightly too small to fit the holes in the parent sheets. Fortunately, metal is malleable. We can stretch it with our planishing hammer to cause it to expand to fit the available space in the parent sheet. We're going to trade a little bit of thickness for a little bit more width. To keep the inserts from being smashed to tinfoil in the effort to fill large gaps, it's important that the kerf be as small as possible, so use the thinnest sawblade practical.

Insert the contrasting insert into the sheet of parent metal, and lay them both face down on the anvil. Use the rounded face on the planishing hammer to tap the center of the insert a number of times. The impact of the rounded face of the planishing hammer will cause the metal to stretch radially around the point of impact. Do this several times, and you'll notice that the insert has grown to the point where it begins to make contact with the edge of the sawn design in the parent metal. At this point, there are several things that you need to keep in mind.

- Once the insert begins to touch the inside of the hole in the parent metal, it is critical that the insert not be over stretched, or struck when it is above or below the parent metal.
- The parent metal will start to curve. It is critical that the insert not be allowed to climb out of the curved surface of the parent metal.
- Individual areas (such as the flower petals) can be planished individually so that they fill their areas once the main body of the insert has been planished.
- It is possible, (and sometimes better) to planish and solder the inserts into place one-at-a-time, rather than trying to do them all at once.



Domed face of planishing hammer.

Planishing the insert.

The flower insert planished into place. Notice that I'm only doing them one-at-a-time.

- Ideally, the insert should be planished until all areas have pressed themselves up against the parent metal, and no cracks of light can be seen between them. Practically, that's unlikely. So stretch the insert as much as you can. Try to get it to a point where it holds itself in place in the parent sheet.
- ***Whatever you do, do NOT*** hit the insert if it overlaps the parent metal at all. This will ruin your fit, and require much filing to correct.

Once the fit is as good as you think it's going to get, it's time to solder the insert in to place. A thing to keep in mind is that it is possible to tack solder the insert into place, and then come back and re-planish to finish fitting the insert. The insert is then re-soldered.

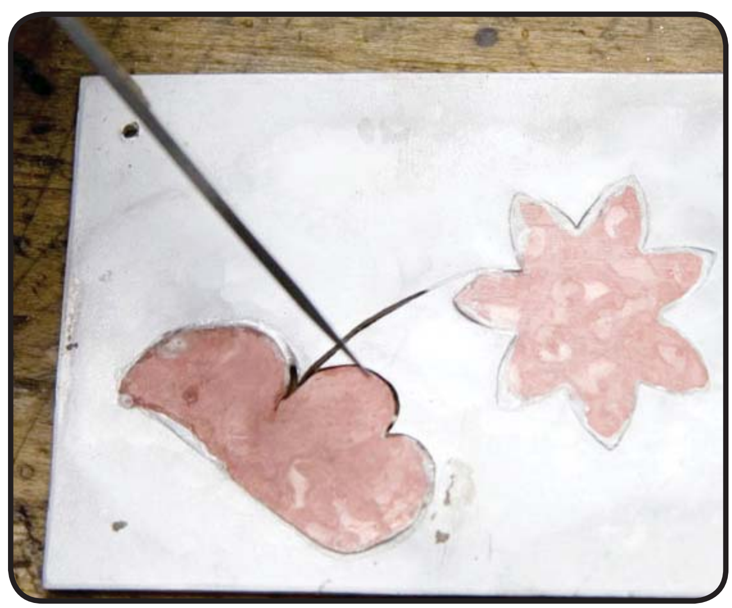
Parent metal with both inserts planished into place. Note that they're tight enough to hold themselves in place.

Step Four:

Solder the inserts into place. The piece is prepared for soldering by placing the parent sheet with the insert in place, face down onto a soldering brick. Coat both sides of the whole piece liberally with flux. Add small snippets of hard solder along the joints from the backside of the parent sheet, with the snippets laying across the joint. Be generous with the solder. It's far easier to clean solder off than it is to add it on later. Ideally, your joints should all be very tight, as solder doesn't like to fill gaps, and will make a horrible mess if forced to try.

Soldering the inserts into place from the back. Note the generous use of hard solder.

Heat the piece gently from the back until the solder flows. Remember to keep heating the whole area of the piece until the solder starts to melt. Only then do you concentrate on one particular area. The idea is for the heat of the metal to melt the solder, rather than the heat of the torch directly on the solder. Once the solder begins to flow, pick one side of the insert, and melt the solder in that area. Then proceed around the insert, drawing the molten solder along the joint as you go. (Solder likes heat. It'll follow the torch.) You do the soldering from the back so that any messes you make are confined to the back, while the front stays relatively free of great lakes of solder. This will make cleanup easier. Once the piece is out of the pickle, check the joint by holding it up to the light. You shouldn't be able to see any light through the joints. Resolder any areas that need it until the joints are completely filled. If they're really wide open, planish those areas to tighten the joint before you resolder.



Inspecting the joints after the first soldering pass. The indicated area was replanished before resoldering.

Step Five:

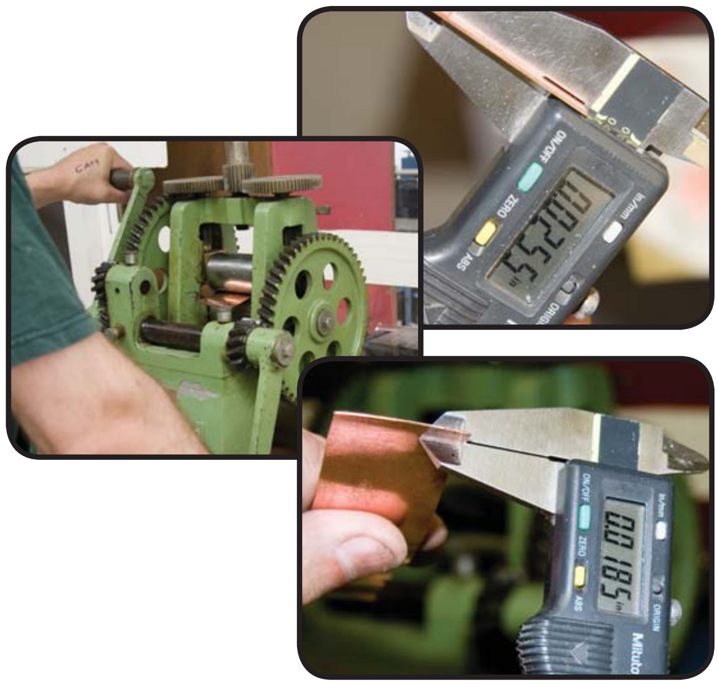
The Lines. With the inserts inserted, it becomes time to concentrate on the contrasting lines. When we first sawed out the pattern, we only cut the one flower stem necessary to allow us to get the saw over to the flower. We used a heavy #6 sawblade to give a wider line. Now that you've closed up the kerf around your inserts, I trust you understand why we used a much thinner blade to cut those sections. The heavier #6 blade will give a wider kerf, and thus a heavier line when filled with contrasting metal.

Resawing stem line with #6 sawblade. Note that the line now extends into the inserts. This helps visually unify the design.

Step 5A: Trust nothing. When I did the sample piece for this handout, I measured the #6 blades I had at the time. I found they were .0185" thick. The first time I taught this procedure, I measured some #6 saw blades that a student had, as they seemed much thicker. Sure enough, they were .0215 thick, and yet they were both #6 blades. Don't assume just because my blades were .0185" that the blade in your saw is anywhere close to that. Measure it.

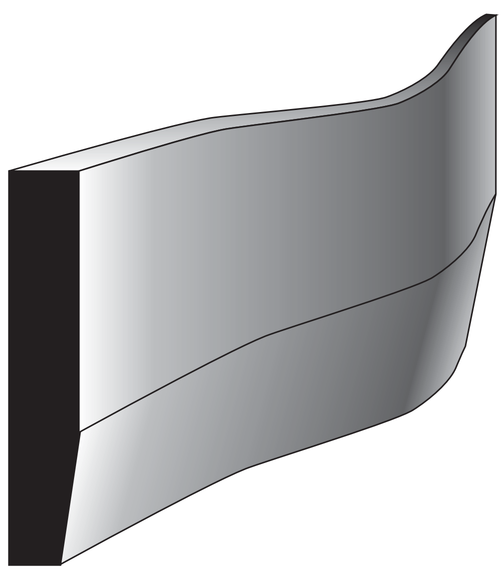
Step 5B: Roll, roll, roll your metal. After determining how thick your saw blades really are, find some scrap sheet metal of a contrasting color. (copper for most of you.) Check to make sure it's thicker than your saw blades. (Hopefully not by much.)

Make sure it's clean, and take it to the rolling mill by the soldering area. Adjust the rolls on the mill so that the rolls just barely grip the metal. Roll the metal through. Measure its thickness. Adjust the rolls down very slightly. Re-roll the metal. Measure again. Rinse. Repeat.



From top:
Selecting contrasting metal to make lines.
Rolling to thickness.
Checking thickness.

The goal is to end up with a small sheet of metal that is either exactly the same thickness as the sawblade, or very slightly thicker. (.001-.005" thicker.) Normally when we roll metal, we reduce it in thickness very substantially on every pass. So we turn the thickness dial on the mill a quarter or half turn on every pass. In this instance we're aiming to reduce the metal by very small, controlled amounts. This means that once you get close to your target thickness, you'll be adjusting the rolls by tiny little increments. Perhaps only advancing the gear by two or three teeth per pass. It's very easy to overshoot, and once you've overshot, that piece of metal is useless. So proceed carefully. Measure twice, adjust in small increments, and check again.



Tapered bottom edge of metal strip to be inserted into line. The exact angle isn't important. The idea is just to make it thin enough to make it easy to get it into the sawn line.

Step 5C: insert the line. Once the sheet is rolled down to size, use shears to cut off a strip from one edge. Cut a strip slightly longer than you think you need to fill your first line, and perhaps 3mm wide.

File a taper onto one of the long edges. This will help you get it started as you insert it into the parent metal. You just need to file one side. All this does is make the strip thinner, so it slides into the saw-cut more easily.

It's generally a good idea to do your big long lines first, before sawing out any smaller ones that connect to the big one. The reason being that if you have a "V" shape where the smaller lines connect with the main line at an angle, those unsupported "V"s in the parent metal are liable to bend or distort when you drive in the metal for the first line. This will make cleanup very difficult. It's better to leave those lines mostly uncut until after the first line is soldered in place to support them. If necessary, saw out a little length of the connecting line, just enough to allow you to get your sawblade back in there once the main line is soldered in place.

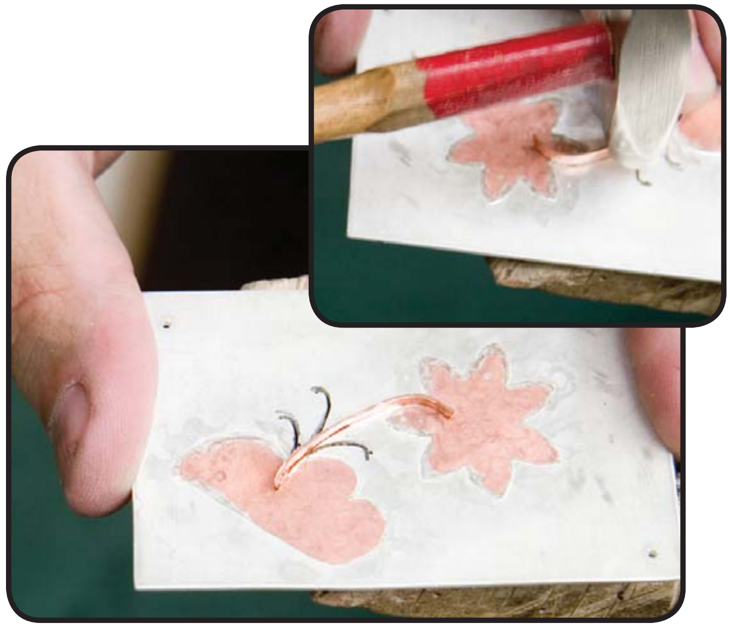
Once you have a tapered side onto your strip, attempt to slide it into the cut line—from the front this time. If it doesn't slide in easily (it probably won't) place the parent metal face up on your bench pin, and use a rawhide mallet to gently drive the strip down into the cut line. If you rolled it to the right thickness, it should slide in without any real distortion to the parent metal. If the parent metal starts bending or deforming, stop and come find me.

The final goal is to have a 'wall' of metal sticking out of both sides of the parent sheet. So long as the metal extends beyond the surface of the back of the sheet, that's far enough. You don't need to pound it any farther through. The extra height is just to give you enough metal to hang onto, and pound on if required.

Step Six:

Solder the lines into place. With the strip for the main line(s) in place, soldering is relatively straightforward. Flux both sides, place the piece face down on the soldering block, and place generous snips of hard solder on both sides of the wire. We're using hard again because you're unlikely to heat up your inserts enough to melt them loose. (be careful you don't.) We're going to need the two lower grades of solder to get the final piece together.

The strip for the line partially inserted.



Driving the line insert into place.
Front view of the line insert in place .

All the various line inserts soldered into place.
Front view.

Step Seven:

Cut & fit any extra lines. With the main lines soldered in place, now is the time to cut and fit any secondary lines or dots. Cut, fit and solder as you did with the main lines. Use hard solder again. The mechanical fit of the wire into the saw kerf will hold the metal in the main lines in place, even if the solder melts. Save Medium & Easy for your final piece.

Step Eight:

Cleanup. Here begins the fun part.

Step 8A: file off the walls. Use a coarse flat file to file the 'walls' left by the strips of metal filling the lines. Get as close to the surface of the parent sheet as you can, but don't file into it.

Step 8B: Use the flex-shaft. Normally, I recommend the use of files in preference to the flex shaft, as beginners tend to rely on them for jobs that should be done by files. For once, this really is a job for a flex shaft. Use whatever abrasive wheels seem appropriate. I recommend starting out with the mizzy wheels. (the stony ones that are white with blue rims.) Then move on to the snap-on sandpaper disks.

Step 8C: crush it. Once you've got the lakes of solder ground off both sides, it is possible to use the rolling mill to even out the metal thickness slightly. You don't have much margin for decreasing the metal thickness, but the rolling-mill will iron out some of the minor thickness issues. Be aware that this will change your metal size, and distort your pattern. If you've got a geometric pattern, don't do this.

Step Nine:

Make the actual piece. Now that you've got the parent metal cleaned up, it's time to start working on your actual piece.

Front side of cleaned up parent metal.
Note that lines have been ground flush, as have inserts.

Flex shaft with snap-on sandpaper disk.

Laying out the pattern for the fan onto the completed sheet of married metal.
Note the pattern revisions to maximize material usage.