A Soldering Tutorial
For Modellers assembling Brass & White Metal Kits

Introduction

'I Can't Solder' - Why are People Afraid of Soldering?

This is a statement that is heard or seen so often, frequently in the form: 'I can't solder to save myself, I am all thumbs.' And yet that person might be a commercial airline pilot, or perhaps a surgeon, with tremendous skills that most of use could not imagine having. Simply, soldering is a skill you can be taught and acquire quite easily.

Often it is not so much that they are afraid of soldering per se, but they are afraid that their inexperience will lead to a perfectly good kit being ruined. The fear is 'fear of losing something valuable'. And that is a perfectly understandable fear to have.

The truth is that for every 5 brass and white metal kits sold, probably 3 of them will sit on a shelf and not be assembled, because the purchaser really wanted to possess the kit, and figures that one day he will learn how to solder and become capable of assembling the kit.

Well, this is where our tutorial will hopefully enable you to make a start on that kit sitting on the shelf.

Soldering is, like any other skill, a skill you can acquire, and it is not that hard to acquire, nor is it difficult to solder well either. I conduct one-on-one tutorials for people on the subject, and after just one afternoon spent learning the technique, most people wonder why they were so worried about it.

The most important factor in being able to solder well, and acquire skill and confidence, is having the correct equipment. More on that later.

What Exactly is Soldering?

The technique of soldering is a method of joining two metal parts together using a metal alloy that is heated to a molten state during the process.

Unlike welding, where the metal used to make the join is usually the same metal as the two parts being joined, solder is rarely the same metal as either of the parts. Further, soldering can be used to join two metal of different types together using a metal of a third type.

The join is made when the solder metal attaches itself to the surface of the two parts and then cools. A solder joint is usually a quite strong joint and not easily broken. During the molten state, the liquid solder flows into the tiny spaces between the two metals being joined using the capillary effect. It will flow easily while it encounters clean metal to wet and bond to, but as soon as it encounters dirt or metal oxide blocking access to the metal's surface, it flows around the obstruction and produces a weaker joint.

This is where flux comes in. It is a chemical that cleans the metal surface of oxides and dirt and at the same time prevents air containing oxygen from getting to the surface and creating more oxide. Raising the temperature of the two metals to be joined also has the effect of increasing oxidation, so the process of soldering is a race to clean, wet and bond the joint before further oxides form. Therefore, by definition, soldering must be done quickly.

You could say that soldering is much like using a hot glue gun, just that the glue is a hot metal instead.

How Do I Learn To Solder?

Without doubt, the best way to learn how to solder is to sit with someone who knows how to do it properly, and most importantly, is ***able to convey the principles and techniques to a student***.

While I thought I knew how to solder, many years ago I was sent to be trained in High Reliability Soldering through a course conducted by the Royal Australian Air Force. I was not employed by the RAAF, but in those days companies could pay to have their technical staff trained in the techniques. I now know that I knew almost ***nothing*** about soldering before I took that course.

Since then, I have taught a number of people to solder, and I still offer this to modellers who are prepared to come and visit me at my home during normal business hours. It takes no more than half a day to impart the knowledge of good soldering, and the most usual reaction upon departure is 'I never realised how easy it was to solder once you know how'.

Today, as part of my business making BullAnt mechanisms and other products, I use a range of quality soldering equipment. And I use it every day, all day. I use a Weller solder station, a Bluerink Resistance Soldering Unit and a Sunkko Hot Air Re-work Station. Each tool has a different job to do in assembling my products. I will explain the use of these tools in this paper.

So, it at all possible, try to find someone who can watch and guide you through your first few solder attempts, but if that is not possible, then reading and understanding this paper will be a good, but lesser substitute.

Chapter 1

The Most Important Tool – Choosing Your Soldering Iron

This is the big ticket item, and also probably the most controversial item on the list, because everyone has an opinion about what constitutes the best soldering iron. Unfortunately, a lot of those opinions are quite misguided. The first rule in selecting ***any*** tool is to choose a quality tool, rubbish tools end up costing more in the long run because you end up paying for the rubbish tool ***and*** its replacement.

There is one important aspect of soldering irons that is not generally appreciated: ***There is no soldering iron designed for assembling brass model kits.*** The great majority of soldering irons sold are designed for electrical or more often electronic assembly work. The exceptions are the large high power irons intended for plumbing work. A soldering iron intended for electronic work usually only has to deal with small electronic components that do not soak up much heat during the process. And for this purpose, they are quite suitable.

For model kit assembly, the parts are larger with more heat sinking area, particularly when you encounter large white metal castings such as boilers, cylinder assemblies etc. These parts soak up heat very quickly, and the average hobby iron cannot cope with them.

In looking for an iron to do the assembly of model kits, we have to look at the irons offered for electronic assembly and try to determine which one has sufficient capability to do the job. And in this respect, it is important to look at what the task requires.

The only thing a soldering iron has to do is to generate enough heat to melt the solder and to heat up the work piece to the melting point of the solder. Until the work piece reaches the solder melting point, it is not possible to produce a solder joint.

Almost any soldering iron can melt the solder, but it is the ability to heat up the work piece that is the critical factor in selecting an iron. And it must do so quickly enough to make a speedy joint before surfaces start to oxidise, and ***most importantly***, fast enough that you do not get frustrated with the waiting time.

There are a number of factors that affect this heat transfer process:

The power rating of the iron. An iron that has a higher power rating will transfer heat to the work piece quicker than a low power iron. This is generally true, however some better designed irons can perform the job with lower power ratings than high power inefficient examples.

Design of the tip on the iron. Not all soldering iron tips are created equal. The cheaper irons quite often have inefficient heating elements that waste electrical energy because they do not adequately conduct the heat generated by the element to the tip itself.

Temperature Regulation. Only controlled temperature irons can regulate the temperature of the tip and the work piece to the correct melting point of the solder and flux. A non-temperature controlled iron must have losses built into the design so that the heating element does not overheat the tip.

Size Does Matter, well Power does!

In terms of soldering irons, there is no substitute for power. I have heard many people say 'You can do just fine with a 25 watt iron'. Yes, you can if you want to sit there all day waiting for it to heat up the work piece you are trying to solder. And interestingly, this is one factor that turns people away from soldering. They try making their first solder joint with a poor iron and insufficient knowledge of the subject. Often this results in the person giving up saying 'I knew it, I can't solder'.

If they had sought tuition in solder practice from an experienced tutor, it is unlikely that this would have occurred. Firstly, the tutor would have made sure they were using suitable equipment and also would have watched the joint being made and offered assistance.

Using a low power iron is analogous to trying to paint the wall of a house with an artist's brush. Yes, it is possible, but whether you will have the patience or can even be bothered to get to the other end is doubtful. If you take a three inch wide brush, you will be more likely to finish the job, as it will take less time to get there. But pick up a wide paint roller, ***the correct tool for the job***, and you will have the wall painted in no time. And into the bargain, you will do a better job than you could have with the paint brush and will be more inclined to tackle the next wall.

It is the same with a soldering iron. The components of a kit can be quite small, and able to be soldered using a low power iron, much like the artists brush analogy. When you get a larger piece of brass, such as the side of a locomotive tender or a carriage side, it soaks up the heat from the iron a lot more than a small brass item does, and this is when a low power iron becomes near to useless. A high power iron is like the paint roller, it is ***the correct tool for the job.***

Soldering Iron or Soldering Station?

A simple soldering iron that has a cord that is plugged into the mains is generally referred to as a plain soldering iron. More sophisticated soldering 'stations' are usually powered from a 24 volt supply contained in a box that sits on your work bench. Often, as in a temperature controlled iron, that box contains electronic circuitry to control the temperature of the iron. For this reason, the makers refer to them as soldering stations.

Do I Buy A temperature Controlled Iron or Not?

The short answer is yes, and not for the obvious reasons. Most people would consider a temperature controlled iron is only required if you are going to solder white metal which has a low melting point. But in reality, a temperature controlled iron is best for ***all*** soldering work. However the term temperature controlled iron is a little misleading, as all soldering irons are temperature controlled by some method, otherwise they would reach a temperature too hot for soldering.

Thermal Equilibrium Control - The simplest of irons are designed in such a way that the heating element does not have a very good thermal coupling between the heating element and the tip of the iron. In this design, the tip of the iron reaches a temperature where the heating element cannot conduct any more heat to the tip so the tip temperature stabilises at the designed temperature.

This design of iron is very common, in fact the most common type of hobby iron is made this way. Generally they are referred to as soldering sticks, that is, it is just a soldering stick with a power lead that is plugged directly into the mains electric supply. They are available in various power ratings from about 15 watts up to around 100+ watts for plumber's irons.

But you should question whether an iron that relies on thermal inefficiency is a good tool for the job you want to do.

Thermal Switch Control – This type of soldering iron has a mechanical thermal switch built into the area just behind the tip. When the temperature reaches the preset temperature, the switch opens, breaking current flow to the heating element and halting the temperature rise. This is a better method, and usually more thermally efficient as it can have good thermal coupling to the iron tip while being able to control the temperature over a certain range.

The disadvantage with this method is that when the tip cools down, the mechanical switch is often slow in re-establishing the electrical connection to the element, so it does not respond quickly to heat being drained from the tip.

The other problem is that it does not allow the temperature of the iron to be adjusted for lower melting point solders.

Magnetic or Curie Point Control – This technique uses the Curie Point or Curie Temperature characteristic of metal alloys, where in simple terms, a metal loses its magnetic ability at or above a certain temperature.

Inside the iron, a moving rod with a magnet on the end is magnetically attracted to the removable tip of the soldering iron. The other end of this rod is connected to an electrical switch. When the iron is cold, the tip of the rod is attracted to the iron's tip, the electrical switch closes and electrical current flows to the heating element, which surrounds the tip. The rear end of the tip has an alloy cap which is selected for its Curie Point value, and when this point is reached, the cap no longer can attract the magnet, so the rod retracts, opening the switch and cutting off power to the heating element.

The main advantage of this type of temperature control is that a range of tips can be offered with different Curie Points, thus providing a range of operating temperatures that can be easily set by changing the tip. This was exploited by the Weller company with their WTCPT range of soldering irons.

The disadvantage was that there is a range of temperature over which this principle would work, called the hysteresis value, making temperature control not precise but between certain values. The response time of the system was also not that good, much like the Thermal Switch Control. In fact, it is simply a thermal switch control using a different and more sophisticated methodology.

Thermocouple Control – A device called a thermocouple, which is actually a pair of wires made of two different metals joined at one end, is used as the thermal measuring device. The thermocouple is placed as close to the tip as possible and measures the temperature of the tip. Electronic circuitry in the soldering station compares the temperature at the tip with the set or desired temperature and switches on or off the heating element to adjust the temperature.

This is the principle used in most modern temperature controlled irons, and has the fastest response along with the most precise temperature setting. There are both analogue and digital version of these stations available, digital stations display the set temperature and the actual tip temperature on a digital display. Analogue stations simply have a rotary knob to set the temperature to a scale graduated around the knob.

While the digital type looks quite flash and professional, the analogue type do the job just as well and are often a $100 or so cheaper. My view is, buy the analogue one and save the money.

All Soldering Irons Are Not Created Equal

And there lies the trap for the unwary in purchasing a new soldering iron or station. It is possible to purchase what appears to be a sophisticated soldering station at surprisingly low prices. A well known example of this is the T2200 Soldering Station sold by Dick Smith. This unit can be bought for under $100 and looks the part.

However when I tested this unit, I found the 48 watt power rating far too low to be capable of soldering moderate sized brass objects. Further more, the iron seems to have a poor thermal connection between the element and the tip, such that when applied to the work, the tip cools down quite rapidly as the heat is soaked up by the work. As a result, the heater tries to bring the tip back up to the set temperature, but it takes a month of Sundays to get there. My opinion of this iron, forget it, it will drive you nuts trying to use it.

Dick Smith are also selling a higher powered version, with a 100 watt soldering pencil, billed as a 'professional' quality unit, their catalogue number T2260, currently selling at $149. While I have not tested

this unit, it could be useable and at least features a decent power rating. Altronics also appear to be offering the same unit as the T2260 under the 'Micron' brand name.

However, it is most likely that this unit is made in China, along with all the other low cost stations available from electronics hobby shops, and for this reason alone, I would be suspicious of its capabilities. When you look at the available accessories, there are only 3 tip sizes offered and they are all the same stock number for the T2200 and T2260 irons.

This suggests that the irons are of similar construction if they are all able to take the same tip, and it brings into question whether they all suffer from the same inefficient thermal coupling between the heating element and the tip. And will you still be able to buy new tips or spares well into the future? Having bought one of these irons, you are going to expect it to last a good 15 plus years, but will the spares supply hold out?

I've Heard You Can Make a Temperature Controlled Iron Using a Simple Dimmer?

Yes, I have heard that one too, many times. And it is not true, putting a normal iron on a dimmer just hobbles the iron. The dimmer acts to reduce the average voltage applied to the iron, that in turn reduces the power rating of the iron, and you end up with a ***less capable iron*** than when you started. As mentioned earlier, you want ***greater*** power for your iron, not ***less***.

A proper temperature controlled iron has a thermal control element to sense the temperature at the tip and adjust the heating power to the iron. A dimmer simply reduces the heating power of the iron without knowing what temperature the tip is. At worst, this method can still see you melting a white metal part, and at its best, provide you with a crippled iron.

The main reason for considering this approach is the desire to save money by using an iron that the modeller already has. And often that iron is not ideally suited to the task anyway, so the net result is to make the situation worse.

What Iron Do You Recommend?

It is possible to spend $800 to $2,000 on a good, professional soldering station, however I doubt anyone reading this tutorial would want to cough up that sort of cash. So, my criteria in selecting an iron to recommend, is based on the best quality tool, with the highest power, for the lowest cost.

My preference is for the Weller range of irons, and the WD1000 is currently the lowest cost iron in their range with a high power output. It is an 80 watt iron and costs in the range of $400.00

The Weller iron is made by Cooper Tools, and is available in many countries. In the USA, the equivalent is the WD1002. The important thing is to make sure it has a type WP80 soldering pencil.

After a bit of searching, I also came up with the Hakko FX-950. The 950 is a 75 watt iron, a bit lower than I would have liked, but it does the job very well with that power rating. It has a very good thermal response, or thermal recovery, meaning it heats up rapidly when the work piece sinks the heat from the tip. The design of the composite tip means very good thermal coupling between the heater and the tip, outperforming many irons of higher power ratings.

In Australia, one of these will cost you around $378.00 including GST and a solder tip. Shipping is extra. This iron is a quality tool made in Japan, and the FX-950 is available in most countries of the world, except the United States, were the equivalent model is the FX-951. The 951 model is a digital version of the 950, but in all other respects seems the same.

If you are in Australia, the Hakko FX-950 can be purchased from Mektronics, telephone 1300 788 701.

In the USA, look up http://www.hakkousa.com/ There are links on the web site showing where you can buy the product, and at last look, the price was around $250.00
For the rest of the world, go to: http://www.hakko.com/ and select your region.