Welding for Software People

Welding is the process of joining two similar types of metal together, by melting them to form a single piece.

The three basic control parameters in welding are power, speed, and extra material. Each system offers some or all of these parameters. The parts to be welded are the other parameter, with thickness, position, and material type all important considerations.

I touch on four basic types of welding, Oxy-Acetylene, Arc, MIG, and TIG. Obviously, these are very light treatments of an extensive field, and it takes a couple of years of classes to become a bonded welder.

That having been said, I'd argue that the best way to start is to take two pieces of mild steel and go crazy on them.

Oxygene-Acetylene

(Touch my valve)

Oxy Acetylene is the oldest form of welding, and uses two gasses, acetylene (explosive) and the oxidizer. It is typically used to weld mild steel, and cannot weld aluminum due to oxidation.

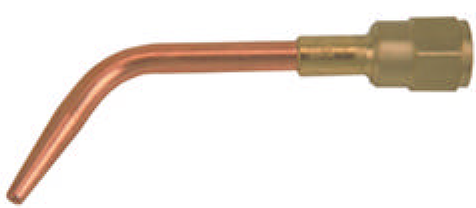
The oxygen and acetylene are fed from two tanks, each with a pressure regulator. From the regulator, two rubber tubes channel gas to a torch handle.

The torch handle has individual flow valves to fine-tune the mixture.

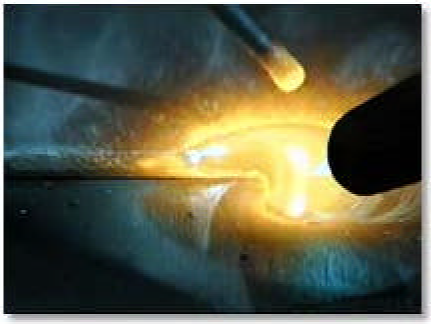
One typically starts by lighting the acetylene first, using a flint striker. This produces a thick, black smoke from incomplete burning. One then adds oxy until the correct flame is produced.

(a good looking flame, seen only in photos)

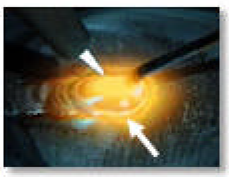
After the handle, there are tips, numbered 0-n, which refer to the size of hole (hence the size of flame).



This is a good-looking weld.



Here, two pieces of metal are being joined. A small gap between them allows for complete heating, while a third piece of metal (welding rod, or copper clad) is brought in to ensure that the final weld is as thick or thicker as the original material. In addition, the copper on the copper clad rod acts as a flux (similar to the rosin in solder) to help smooth the process.



Here the rod is being brought down into the "puddle."

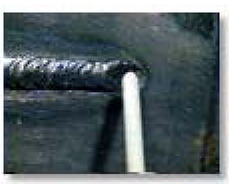
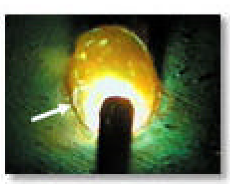
One moves the puddle forward, leaving a succession of "ripples" behind.

Without the rod, the work will flatten or become thinner.

This method is readily available, portable, and doesn't require power (read: Burning Man) but the prolonged, general heating can cause distortion in sheet metal and rod stock. Due to this, this method has been, in some cases, displaced by other methods such as Arc, MIG, and TIG welding.

ARC (Sputter Box)

Arc Welding uses electricity and a flux-encrusted “stick” to join the metal. One starts by “striking” and arc, touching the stick briefly to the metal. One then hold the stick right above the metal, causing the stick to turn to plasma and flow toward the metal, melting it in the process. Much as in Oxy, one keeps a puddle moving forward along with the arc. As with Oxy, arc welding is used for mild steel. The arc produces ultraviolet light, so eye protection must be used, and care must be taken to prevent unwitting passers by from exposure. Additionally, arcs use many jolts of electricity, so care must be taken to avoid being ground.

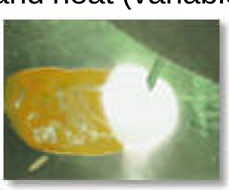
Arc is the ugliest welding process, in that it produces sputter, somewhat dangerous gasses, and is hard to see and set up.

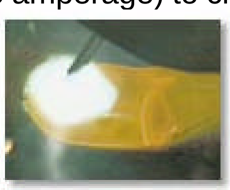
MIG (GMAW)

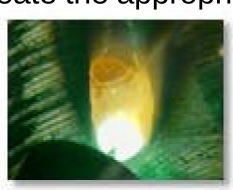
Metal/Inert Gas welding uses a wire, electricity, and gas to produce clean, fast, repeatable joins. An inert gas surrounds the arc and shields it from the atmosphere to prevent oxidation. Argon, Nitrogen, and “Tri Gas” are commonly used, depending on metal and application. MIG can weld aluminum as well as steel.

The wire starts on a spool within the welder. When the handle is pressed, three things happen. First, the wire is fed through two rollers into a long tube to the handle. Second, the shielding gas is fed through the tube, so that it forms an anti-oxidizing field around the weld. Third, voltage is presented on the wire, causing an arc.

Again, one varies the amount of new metal (wire feed speed, rate of weld travel), and heat (variable amperage) to create the appropriate weld.







MIG welds tend to be clean, although with some splatter, and because of the lack of oxidation one can weld several times over the same spot. The drawback is that one cedes the parameter of amount of new material to the machine.

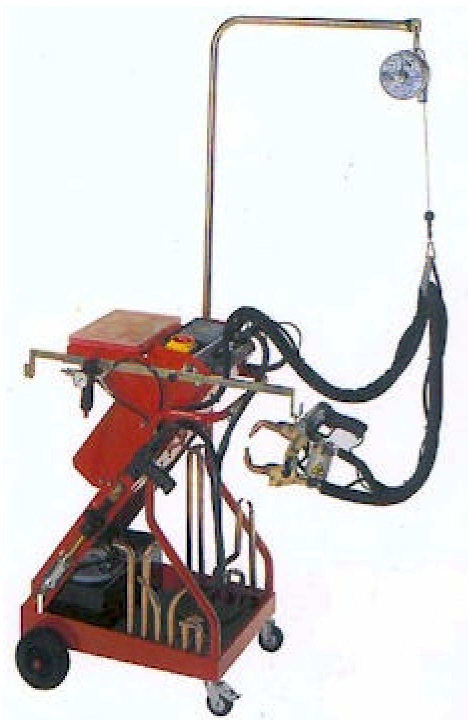
As with Arc and TIG, MIG welders produce UV light, and can burn through your retina before you know it.

TIG

Tungsten/Inert Gas

I won't cover this, but TIG welding offers similar control of parameters to oxy, while combining the cleanliness of an inert gas system.

Spot



Spot welding is used when full joins are not necessary, and especially on plate and sheet metal, where the warping caused by other welding techniques would be unacceptable. Most metal chassis are spot welded. Two electrodes, typically copper, are placed outside two directly abutted pieces of sheet. Electricity passes through the electrodes to the sheet, where the resistance of the metal leads to heat, causing melting and joining.

End Notes

MIG welding can be used for thicknesses from 0.5mm to 6.3mm. TIG can be used for thicknesses as low as 0.125mm. Spot can be used for aluminum foil, while Oxy is typically useless on metal under 1 or 2mm. Too thin a material and the pressure from the arc or gas will "punch through," dissolving material rather than melting it.

Weld strength can be up to the strength of the underlying material. Typically, it is better to increase material thickness. Excess material can be removed, if necessary, with a metal grinder. It's a good policy to saw through your first welds to examine their silhouette, making sure that they are consistent and complete.

Material Preparation

Material should be cleaned and degreased to remove all debris. Hot rolled steel may require the use of a wire brush to remove scaling & oxides.

Material should be fixed / clamped and weld tacks should be kept up to 50mm apart to reduce heat distortion in the welded part. Use of a heat sink can also reduce weld distortion.

If possible, parts should be made that are self locating – the use of weld buttons is one example – so that as few fixtures and clamps as possible are required. This speeds up the whole welding process.

Weld locations should be designed with the welding operator in mind. Attention should be paid to whether the operator can gain easy access to the weld. Parts that require painting will require sanding & grinding at the welds, this should be taken into account when calculating the costs of the process.

Parts that require electroplating should have no overlapping seams this would lead to the trapping of plating solution and an accumulation of salts, which could prove detrimental to the weld integrity.