**SHEET METAL**

Machines:

Bar Folder, Box and Pan Break, Square shear

The bar folder folds hems to a given size depending on where you set the teeth. The bar folder requires 2 bending operations to complete a hem.

The Box and Pan break is used to fold the sides and ends of your project. It has movable teeth that can be set to different sizes.

The Square shear is used to cut metal in long straight lines. I can cut 90 degree angles or any straight line when held at an angle.

Layout:

When working with sheet metal we can use three different layout techniques. A pattern is usually made in one dimension out of paper and is used to transfer an image to the metal. To use a pattern many times you need a prick punch or carbon paper to transfer the image. A template is a three dimensional object made of something solid that we can trace around. Usually this will only transfer exterior lines; interior lines will have to be added later with a ruler. When tracing a template, the image you trace will always be larger than the original. Stretch out is where we have a plan that shows our dimensions and we measure out every line of the project. This takes the longest but is the most accurate of the layout options.

Bending:

When bending sheet metal there are bends that give us both strength and safety. Hems can be either single or double, folding over once or twice. A hem folds over on top of itself to form a stronger and smoother edge so that we do not cut ourselves. Remember that a double hem takes 1/16th more material to do. When we bend sheet metal we must bend in a certain order, we bend hems first, then ends then bends. We also want to be sure to clamp metal to the table or hold it in vice grips before drilling.

Size and type:

Sheet metal is any metal thinner than 3/16 of an inch. It is measured in gauge size and sized by a wire gauge. We need to make sure what type of metal we are working with since metals like stainless steel and aluminum can also be in sheet metal sizes. Galvanized sheet metal has a coating of zinc that keeps the metal from rusting but also creates a toxic fume if heated with a torch. This can cause you to get sick or even die.

**OXY WELDING**

Equipment:

Cylinders for oxy acetylene welding have different safety measures in place. Acetylene tanks are left hand threads while oxygen tanks are right hand threads. This ensures that we do not put the wrong regulator on the wrong tank. Acetylene cylinders are tested every time they are filled for weight while oxygen tanks are tested every five to ten years for pressure. We need to make sure that we open oxygen cylinders all the way to prevent gas leakage, while acetylene tanks only get opened ¼ to 1 full turn. We never apply petroleum products like oil to oxy equipment since there is a possibility of spontaneous combustion. Acetone is a chemical added to the acetylene cylinder to help provide a stable environment for the acetylene gas.

Pressures and Flames:

Regulators should be checked prior to lighting the torch to ensure that the adjusting screws are off and free to move. Once the proper steps are taken care of, oxygen pressure for welding is 7 p.s.i and 30 p.s.i for cutting. Acetylene pressure should be 7 p.s.i for both functions. If acetylene pressure rises above 15 p.s.i. on the line regulator, an explosion could occur. The oxy acetylene torch has three flames, carbonizing, neutral and oxidizing. The neutral flame is the one most commonly welded with and is between 5,500 and 6,000°. It is important to watch where the flame is pointed; pointing the torch at galvanized metal can cause toxic fumes while pointing it at concrete may cause the concrete to explode.

Welding:

The correct torch tip angle is 20° from perpendicular for a flat weld. If the torch is not hot enough to melt the metal completely it can result in too shallow of penetration. If the liquid metal gets too hot it can spark uncontrollably or boil which will result in a popping backfire or sag in the weld. If for any reason the flame moves back in the torch and black smoke comes out of the tip, this is a flashback and must be handled quickly. The oxy acetylene goggles have a shade 4-5 lens and must be worn at all times while welding. You must know the steps to start and stop the torch in order to use the torch safely.

**ARC WELDING**

Equipment:

The arc welding machine can be run on DC or AC electricity but we run only on DC+ in Intro to Metals. All of the welds that we do are made with the 6013 electrode. While welding it is important to use the appropriate welding hood with a shade 10-12 lens. You need to make sure that you never change the amperage on your machine while it is running.

Welding:

The electric arc can reach as intense as 9000°. As with oxy acetylene welding, the correct electrode angle is 20° from perpendicular. Welding is a fusion process where both pieces are melted and fused at the particle level. Your protective equipment protects you from ultraviolet and infrared light. While welding there is a chance of Arc blow, this is a scenario where a magnetic current causes your weld to split. Also, if you have too long of an arc length you can experience intense spatter and heat. If you have too long an arc length and too much heat you can also have undercut. Undercut is a trough or erosion on either side of the weld.

**SAFTY**

It is important that you understand fire safety in case of an emergency. Know class A, B and C fires and how to handle them. Class A fires involve combustible materials, Class B involve combustible fluids and Class C fires involve electricity. Class C fires must be extinguished with a fire extinguisher no matter what.

**TOOLS**

Hand tools:

We must know hand tools not only by sight but by name and use as well.

Hacksaws and files must be used with two hands and only cut on the forward stroke. A single cut file has individual teeth while a double cut file has two diagonal rows of teeth to cut faster. Since files and hacksaws only cut on the forward stroke, their teeth point away from the handle. File teeth are cleaned with a file card which is a small wired brush. When making a cut with a hacksaw or any cutting tool, the cut made is referred to as the kerf, the metal removed when cutting. While filing or cutting the metal should be held tightly in a vice and close to the jaws to avoid excessive movement.

Hammers come in many shapes and uses. Hammers are separated into hard faced and soft faced categories. Hard faced hammers deform the metal they hit while soft faced hammers absorb the impact of the blow and are deformed themselves. Soft faced hammers like a mallet will not do the same job as hard faced hammers like the ball peen. Ball peen hammers are usually used to make rounded impressions in metal.

Pliers and vice grips come in many shapes and uses as well. Pliers are used to grip hot metal or to turn some objects. Vice grips are used when a tighter grip is needed. Major types of pliers are slip joint pliers which can switch between two different sizes and adjustable pliers which have grooved joints to adjust to several sizes. Vice grips are used to control metal while drilling or grinding, never pliers. Most of the bending on the flowers we make is done with needle nose pliers. Pliers made for welding are known as welpers.

Other hand tools help us in a variety of ways. Punches come in several forms like prick punches and center punches. Prick punches have a 60° point and are used for enlarging holes. Center punches have a 45° point and are used to mark holes for drilling. There are several types of squares, combination, speed and carpenters are three. Combination squares have three attachments, center finding, protractor and 90/45. Scribes are used to layout lines on sheet metal. They are also known as awls or scratch awls.

Wrenches have different uses and must be judged accordingly. A box end wrench is one size and completely enclosed, while an open end wrench is also one size but is only closed on three sides. A combination wrench has a box end on one side and an open end on the other. An adjustable wrench is sometimes known as a crescent wrench although that is only a brand name.

Tables and benches have uses as well. Tables are used for layout and paperwork. The stake anvils on their bench are used to shape metal and hammer down rivets on our projects. Major hammering should be done on wood tables, not on metal.

Grinders come in two types in Intro to Metals. Bench grinders are stationary and are used to prepare the edges of our metal for welding. Portable grinders are used to prepare the face of the metal for welding. When using a bench grinder only ferrous metals can be ground, no soft metals like brass or aluminum. The grinder rest must be no more than 1/8” gapped from the wheel for safety and we never grind material under that thickness so it doesn’t get sucked into the wheel. Always grind on the face of the wheel not the edges for safety and longer wheel life.

Drills can also be stationary or portable. A hand drill is less accurate than a drill press however. Drill bits are sized in four ways; alphabetical, decimal, fraction and metric. The smaller the drill bit the faster the speed, the larger the drill bit the slower the speed. Drill bits have straight and tapered shanks and this is where the size of the drill bit is stamped. When drilling a large hole, drill feed must be taken into account. This is the rate that the drill bit is fed into the work. Many times with a larger hole a smaller hole called a pilot hole is needed. The drill flutes help to remove chips from the drill hole.

**FORGE**

When forging metal always make sure to hit the hot metal and not the anvil. While tapering a piece on the anvil, the metal you are hitting must be held level and the hammer brought down at an angle. Heat treating steel for hardness, like our chisels takes two heats and cooling in oil.

**Lathe**

The tool must always be on center for the best cut. Tools are made out of high speed steel or carbide. The compound tool rest should be set at 61/29 degrees for the best cut. The compound tool rest is used for cutting tapers or champers in metal. The live center has a 60 degree point. Live centers rotate with the work dead centers do not. Back gears is a slow powerful speed used for knurling and parting. The clutch of a lathe engages the automatic feed on the carriage. To face the automatic feed must be in the cross feed position.

**GMAW**

Advantages to GMAW are: shorter training time, more cost effective, narrower heat affected zone, easier to learn, high deposition rate. Disadvantages are that it is prone to wind drafts and that you must have accurate settings. The stick out is the distance between the contact tube and the plate. Increasing the stickout increases the voltage and decreases the amperage making the weld colder. The shielding gases are inert and the most commonly used are Argon/CO2 and CO2. We use DCEP when wire welding which gives the narrower heat affected zone and deep penetration.