SCULPTURE SHOP GUIDE

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1 General Shop Safety
All students using the School Facility and Equipment Must Follow these Safety Rules:

- Wear safety goggles to protect your eyes when working with power tools and equipment or when tools are being operated around you.

- Wear clothing that does not interfere with your ability to operate machinery safely; Do not wear long or loose clothing or jewelry that can get caught in moving parts of machinery.

- Tie back long hair so it will not get caught in moving parts of tools, causing injury.

- Wear shoes (closed toe) that protect your feet from falling debris and sharp objects.

- Use ear protection and dust masks as necessary.

- Do not operate any equipment while under the influence of drugs or alcohol. You will not be allowed in the studio if you are under the influence of drugs or alcohol.

- Always pay attention while using tools, being distracted from the task you are performing can cause you to be injured.

- Keep hands away from moving blades and belts on equipment.

- Use a clamp or vice to secure the work when using tools on it that can spin or through the work.

- Use only extension cords rated for the same or a higher amperage as the tool.

- Do not operate electric tools in wet environments where electric shock can occur.

- Do not use excessive force with tools that can damage the tool or cause you to slip and get injured.

- Avoid accidental starting, be sure switch is off before plugging a tool in.

- Do not abuse the cord by yanking it out of the plug or carrying the tool by it.
• Never use or continue to use an accessory that appears damaged.

• Never remove guards or use a tool without its proper guards in place.

• When using power tools that create vibrations, take brakes to limit your hands
  • exposure time to damaging vibrations.

• Grinding, sanding or cutting metal create heat and sharp edges or burrs, use caution.

• If you are unsure of how to use a tool, get help from your instructor before proceeding. Do not Use any processes, materials or equipment that have not been reviewed by your instructor.

2 Clean Up
Always clean up after yourself as you work, saw dust on the floor creates a slipping hazard, wood scraps create clutter and mess that makes a difficult working condition. Leave the work areas clean for others to use.
3 Wood Fabrication

3.1 Wood Types/Qualities

3.1.1 Wood Grain
Wood has a grain to it in relation to the way the tree had grown. Wood will break on the grain, take this in consideration when planning your pieces. Wood boards should also be checked for straightness when purchasing. Bowing, bending along the length, is common in boards.

Knots in wood boards are hard circular cross grain where a branch intersected a trunk. They tend to lower a board’s rating in the case of pine as they can cause weak spots if they fall out and can be difficult to nail or saw through as they are harder than the surrounding wood.
3.1.2 Soft Wood

Soft wood is a term used to describe wood from trees that are need bearing, conifers, such as pine. Some soft woods can be stronger than hard woods. Soft woods are generally cheaper than hard woods and commonly used in construction of moderate sized structures. Common dimensions of soft wood lumber nominal (actual): 1x2 (.75”x1.5”), 2x4 (1.5”x3.5”), 2x6 (1.5”x5.5”), 4x4 (3.5”x3.5”)  

*sometimes wood is measured in board feet, say if buying a large amount from a lumber yard. Board feet is measured: thickness x width x length (in inches) divided by 144 equals board feet. A 1”x12”x12” board would equal 1 board foot

3.1.3 Hard Wood

Hard woods are generally denser and more expensive than soft woods and therefore reserved for situations requiring their strength and appearance.

3.1.4 Plywood

Plywood is made up of layers of wood laminated (glued) together, with grain directions altering to give strength. There are different grades of plywood based on number of layers, strength and surface layer. Some are rough while others can have a top layer (veneer) of more expensive wood. Sheets range in thickness, but generally come a standard 4 foot by 8 foot panel.

3.2 Measuring/Layout

3.2.1 Tape Measure

A tape measure is flexible metal tape with measured increments that is designed to spring roll up in to a compact container
3.2.2 Ruler/Yard Stick
A flat stick with measured increments either in English or Metric measurements.

3.2.3 Compass
A tool uses to draw circles and arcs.

3.2.4 Square
A tool, usually with measurements that has sides that are set at 90 degrees to each other, for drawing lines 90 degrees to each other or checking square ness of an angle. Some types of angle drawing tools, such as a combo square or a triangle, have other angles on them. The sliding T bevel has an adjustable angle.
3.3 *Joints*

- lap
- dado
- mortise and tenon
- tongue and groove
- miter
- butt

*Organic shapes can be formed in wood by cutting and laminating sections together and then sanding.

Shapes are drawn on board, then cut out, stacked, glued and clamped together and then sanded down to the desired shape.
3.4 Fastening

3.4.1 Nails/Hammer

A hammer is used to put the nail into the board by hitting it squarely on the top, glancing blow can cause the nail to bend.

A pilot hole can be used to guide the nail and prevent the wood from splitting. A pilot hole is a hole drilled that is slightly smaller than the diameter of the nail and 2/3rds its length.

The heads of finish nails are usually driven flush to the surface of the wood or slightly recessed by using a small punch called a nail set. The shallow hole left can be filled with wood putty and painted over if so desired.

Nail size lengths: 4d=1.5”, 6d=2”, 8d=2.5”, 10d=3’

Nails can be driven at slight angles to each other in order to give better holding strength than if they were parallel to each other.

Glue is used to adhere surfaces along with nails. Boards fastened with nails by themselves, can be pried apart.
3.4.2 Screws
Screws have much more holding power than nails since their threads grip into the wood. Screws can also be removed by turning them counter clockwise. Three (3) common types of drive heads on screws are: (as seen from the top)

- slotted
- phillips
- square

Screws can be driven by hand with the appropriate driver or a drill can be used to drive the bit with an appropriate driver bit. Often it is easier and less likely to split the wood if you drill a pilot hole (a hole slightly smaller than the center shank of the screw, although some screws with larger shanks towards the top may require special pilot bits) and a counter sink can be used to drill a divot so the head of the screw sits flush with the surface of the wood.
When using a power drill to drive a screw, keep the driver bit seated in the screw head by applying pressure and using moderate speed on the drill. If the bit begins to slip in the screw head, stop and reset the bit in the head. If the bit is allowed to continue to spin in screw slot it will strip out the slot and/or wear out the driver bit to the point it is unusable.

3.4.3 Wood Dowels
Wooden dowels (round wood rods) can be used to fasten wood by drilling holes that match them and applying glue to the wood surfaces and in hole and driving in dowels with a mallet. Ends of the dowels sticking up out of the wood can be cut and sanded down to the surface.

3.4.4 Glue
Wood glue, usually a polyvinyl acetate, white or yellow, is used in most applications. Pieces being glued without fasteners should be clamped firmly while the glue sets, usually 2 to 4 hours. Other types of glue are stronger such as an epoxy or polyurethane glues, but are higher in cost.
4 Metal Fabrication

4.1 Types of Metal (you may come across in this course)

4.1.1 Wire

Wire can be cut, bent, twisted and/or forged. It can be used to stitch together sheets of metal or bent and curved to form linear elements of your design. You can twist wire into cable to give it more mass and courser texture.

4.1.2 Rod

Rod, like wire in shape but 1/8” or thicker, can be cut, bent and forged. Ends can be threaded so it can be bolted on to a piece of sheet metal.

4.1.3 Sheet/Plate

18 ga. thickness sheet metal can be cut, drilled and formed easily. Thicker metal sheet (referred to as plate) can be used, but some equipment will not work with thicker metals. The larger the gauge number the thinner the material: 24ga. is thinner than 18ga. and at 1/8” thick and thicker it is most commonly labeled by fractions of an inch (US). Mild steel is a softer steel than stainless, aluminum and copper are softer than steels. For ART120 students, softer/thinner for our purposes mean it is easier to cut, bend, drill and shape. Note: while lead is softer yet, do not bring it in due to the health issues. Also be careful if sanding metals or coatings on metals, dust from these can cause health problems, wear a respirator and clean up dusts. For ART220/ ART123 students: Mild steel welds readily. Other metals can be welded, but you may need to purchase special supplies. Check with your instructor first. For welding, avoid metals with coating such as galvanized steel, chromed steel or painted metal. Welding is discussed in a latter section of its own section.
4.2 *Metal Forming Cold*

4.2.1 Working with Wire

Wire in a spool, 16ga. annealed. This wire is referred to as bailing or tie wire and is relatively easy to bend for a steel wire. Not as soft as aluminum or copper but the rigidity of the steel wire can be useful in that it stays where you bend it better than softer wires.

A power drill being used to twist the wire together to create a thicker more textured wire.
Note some different effects of working the wire. Left to right: hand twisted together, singe wire hand straightened, single wire straightened by using twisting with drill, 2 wire twisted together with drill, 4 wires twisted together with drill.
Using pliers to grip the wire.

Different looks of twist connections.

Using a hammer to flatten the wire. Look of the wire is changed by flattening.

Wire can be bent into shapes such as squares and then connected together to create open forms, such as a wire frame cube. This could also be done from one continuous wire as well. Wire can also be woven together to create more closed forms.
4.2.2 SHEET METAL BRAKE

Sheet with clamping bar up. Clamping bar clamped down. Lifting the forming bar.

For straight bends in 16 ga. or thinner sheet metals (depending on hardness of metal).
- Bend only sheet stock in the brake. No round stock.
- Adjust the clamping bar correctly to suit gauge of metal being formed, and stand clear of the moving part of the brake.
- Sheet metal can be cut and folded to create enclosed forms such as a cube.

4.2.3 PLANISHING HAMMER

A pneumatic hammer attached to a stand so that it hits a small anvil for forming compound curves in sheet metal.
- 16 gauge max. capacity mild steel sheet.
- Keep fingers clear of hammer when in operation.
4.2.4 SLIP ROLLS

Rolls for curving sheet metal and rod into curves. Metal is fed in the back 2 rollers which push it through and 3rd roller causes the metal to bend by its position. The 3rd roller can be adjusted closer to the back rollers to get a smaller radius curve and farther away to get a larger radius curve.

- Keep fingers away from the rollers when feeding the metal through.

- Do not exceed max. capacity thickness-20 gauge sheet for full width and 3/16” diameter rod.

- Only roll rod in rod grooves.
4.2.5 STAKES/SWAGE BLOCK

Stakes and Hammers. Hammering metal over stake.

Swage Block

Forms for shaping sheet metal over. Be careful of hitting your hands with the hammers and sharp edges on metal.
The Bending frame with swing arm and bending blocks.

Dies and Instruction Manual. Video: http://www.youtube.com/watch?v=g0P3aubl1W0

The Iron Bender can bend a variety of types of stock including bar and tubing. The instruction manual has diagrams of various set-ups.
- Follow set up instructions in manual.
- Keep fingers out away from dies and pinch areas when moving swing arm.
4.3 Metal Forming Hot (forging)

Forging tools

A forge is used to heat the metal to make it softer to bend. Heating the metal can alter some of the characteristics of the metal. ART175 Blacksmithing is a course that goes over more detail the forging process and tool making.

- Use only after being individually supervised.
- Assume metal surfaces are hot.
- Wear heat protection, leather gloves and apron as well as safety glasses.
- Be careful even with gloves on, they are not indestructible and you can burn your hand in a glove, never use wet gloves (steam burns). Do not handle thing that over heat your gloves, use tongs.
- Follow the usual safety guidelines for dress, but also do not wear synthetics. Synthetics, unless specifically designed nonflammable, burn more readily than cotton denim or other natural fibers.
4.4  FASTENING Cold *(welding covered in its own section)*

4.4.1 SELF DRILLING SHEET METAL SCREWS

A screw for attaching sheets of metal together that drills its own hole. This screw can be driven into the metal using a power drill with a philips bit. Other screws for metal need to have a pilot hole to allow them to get through the metal. The pilot hole needs to be small enough diameter to allow the threads to cut into the metal and hold the sheets together. Follow safety procedures for using a drill.

4.4.2 POP RIVETS

Pop rivets are placed in a pop rivet gun, with long thin part inserted into correct die. Holes are drilled or punched in the sheet metal where they are to be connected and the Hat part of the rivet is place through both holes. The Handle of the gun is squeezed and the thin part of the rivet is pulled through, crimping the hat part of the rivet so it holds the sheets together. The handle is squeezed until the thin part of the rivet breaks off, which needs to be removed from the gun and discarded.
4.4.3 TAP AND DIE

A tap is used to cut threads into a hole in metal and a die is used to cut threads onto a metal rod. The threads are threads as on bolts and nuts, so that you can make parts that thread together. There is a chart with the tap and die set that lists the size hole needed for the size tap. NEVER FORCE A TAP, the hardened metal will break, ruining the tool, the work and can cause an injury. Turn tap and dies back a half turn after each full turn to keep the tool from seizing in the metal.
5 Tools

Follow All Shop Safety Rules and always have Eye Protection

5.1 Cutting Tools

5.1.1 Cross Cut Saw/Back Saw/Dovetail Saw/Pull Saw (wood)

Cross cut saw, a hand saw with 4 to 12 teeth per inch, for cutting across grain of wood.

Back saw used in miter box

Dovetail saw with fine teeth for precise cuts.

Pull saw, fine tooth saw that cuts on the pull.
5.1.2 Rip Saw (wood)
a longer hand saw with less teeth per inch than a cross cut, for cutting with grain.

5.1.3 Coping Saw (wood/plastic)

Coping saw, a hand saw with a “U” shaped frame holding a fine narrow width blade, for cutting fine curves.

5.1.4 HACK SAW (metal/plastic/thin wood dowels)

Blades come in various number of Teeth Per Inch or just listed a “T”.
Below is a image of a 10” blade with 24 teeth per inch.

Some blade recommendations:
14T for 1/2” or thicker metal,
14-18T for 7/16”-1/4”
18-24T for 1/4” to 1/8”
24 to 32 T for 1/8” and thinner.
The blade should be mounted in the hack saw frame with the teeth facing forward.

Image above shows teeth facing forward to the left the direction of the cutting action.
Tension should be set so the blade is tight in the frame. The metal stock to be cut should be clamp securely with a minimum of over hang, so the point where the cutting is to happen is close to the clamp as not to vibrate while cutting. Wood can be used to back up thin metal that vibrates to much. On the forward stroke use moderate pressure and on the return stroke relieve pressure. Do not force the the hacksaw as injury can occure from the blade breaking. Also be careful on the beginning strokes with the hacksaw that you do not slip and injure your self.
5.1.5 COLD CHISEL (metal)

A cold chisel has a more obtuse angle at the point of the cutting surface than a chisel for wood and is often used to cut thin metal or shear thin rods or bolts. Hold the chisel securely and keep thumb and fingers off of the head of the chisel. Use a hammer that matches the size of the chisel to hit the chisel head.

As the head of the chisel mushrooms over time it should be ground down to prevent breakage during striking with the hammer which can result in injury. Wear safety eye wear to protect from metal chips.
5.1.6 Table Saw (wood, plastic)

Feeding a plywood through the table saw.  Guard raised to show blade.

Using the push stick.  Using the miter gage.

The Table saw is a highly used piece of equipment in a wood shop. It can be used to do a variety of types of cuts using its fence, miter gage and other types of cutting jigs. Care and control are important as the table saw not only has the hazard of a moving blade but can throw pieces being cut back at the operator. This happens if the wood binds up on the blade. Proper operation of the saw and use of the guard can prevent accidents. The table saw guard includes 3 parts: 1. a cover that covers the blade but allows wood to slide under it, 2. a splitter that keeps the kerf (space the blade cuts out of the wood) from binding up on the blade and 3. anti-kick back pawls that keep the wood from moving back towards the operator. Never stick your hand under the blade cover while the blade is moving, make no adjustments while the blade is moving. No student is to use the saw with the guard altered or removed. Do not use the table saw until you have been checked out on it and always follow the safety procedures.
The Guard should be down touching the table when you start the saw, all adjustments should be made with the blade at a complete stop. Have a push stick at hand if the space between the blade and the fence is less than 6". As the wood is fed along the fence the guard will raise as the wood comes in contact with the angle plexi glass piece on the front of the guard. Never reach under the guard while the blade is moving.

Use the fence for ripping or cutting along the longer length of the wood.

Use the miter gage when cross cutting or cutting across the shorter length of the wood. You can also use the power miter saw for this cut. Never use the fence to guide a cut that should use the miter gage, if the wood wobbles as you move it along the fence the wood can lift up and kick back at you.
As you feed the wood keep the edge facing the fence firmly against the fence. With larger pieces you may use both hands, but never put your hand under the guard. If you are using 2 hands the front hand can be applying adequate pressure on the wood against the fence in front of the blade--DO NOT PUT SIDE PRESSURE ON THE BLADE. As the back hand moves the wood forward it will reach the fence area. If at this point you need to use a push stick (6" or less between fence and blade) keep the front hand in place hold the wood and pick up the push stick with your back hand, and use the push stick to feed the wood the rest of the way, till the wood between the fence and the blade is out of contact with the blade (out on the other side of the guard). If the size of the wood on the none fence side of the blade is small enough not to need support, you may let the front hand off once the wood is being securely pushed through by the other hand with or with out push stick.

A video about kickback:
http://www.youtube.com/watch?v=sVpGi85HfnY
Of course the splitter and anti kick back pawls help, not to mention the guard cover and a better push stick.

Table Saw Safety:
Follow All Shop Safety Rules and always have Eye Protection
-Always have the guard in place.

-never free hand cuts, use the fence or miter gage to guide the work. Do Make sure the fence is out of the way when cutting with the miter gage.
-Use a push stick when the distance between the fence and blade is less than 6”.

-When cutting with the fence, keep control of the wood between the blade and fence with your hand or push stick and push it so that it is completely through and out of contact with the blade before you release it.

-Wait for the blade to come to full speed before beginning the cut.

-When you adjust the fence to cut, check that the fence is parallel to the blade and locked.

-Make all adjustments when the blade is stopped.

-Do not stand directly behind blade or wood that is between blade and fence.

-Never reach over the blade.
- Do not set the fence so that it is touching the guard or to close to allow the wood to be safely passed by the blade.

- Do not try to feed stock through the saw that is too large for you to control, get assistance or use a different saw.

- Do not cut small pieces that can not be supported by the fence, miter gage or cause you to have your hand closer than 6” to the blade.

- Do not cut wood that is too warped that it will not stable against the fence or miter gage. The edge of the wood riding along the fence should be straight.

- Never cut wood with nails in it with any of the power saws, remove the nails.

5.1.7 Compound Sliding Miter Saw (wood, plastic)

A crosscut is cutting wood across the grain at any angle. A straight crosscut is made with the miter arm at the zero degree position. Check the slide feature to see that it is locked and does not slide. The rail locking knob is right side of the saw behind the motor, tighten it if it is not tightened already. Set and lock the miter arm at zero, hold the wood firmly on the table and against the fence, keeping your hand at least 6" away from where the blade will contact the wood. Turn on the saw by squeezing and holding the trigger. When the saw comes up to speed, about 1 second, lower the arm smoothly and slowly to cut through the wood. Let the blade come to a full stop before raising arm.
For cutting anything wider than the locked slide will allow, use an out-down and back motion with the rail lock knob loosened. Pull the saw out, toward you, turn on the saw, lower the saw head down toward the work piece, and push the saw back to complete the cut. Do not allow the saw to contact the top of the work piece while pulling out. The saw may run toward you, causing personal injury or damage to the work piece.

Angled, beveled and compound angle cuts can be made on the compound sliding miter saw. When making adjustments to saw, make sure that all adjustments are locked/tightened.

**Compound Sliding Miter Saw Safety**
Follow All Shop Safety Rules and always have Eye Protection
- Keep hands out of the path of the saw blade. NEVER CUT A PIECE WHERE HAND WOULD BE 6" OR LESS FROM BLADE.

- Keep wood firmly (clamped or held) against fence and table while cutting

- Do not have your arms cross over in front of the blade when holding the wood in place.

- Do not perform any operation freehand, that is without holding or clamping the work piece against the fence and saw blade.

- Never reach in back of the saw blade.

- Turn off the tool and wait for saw blade to stop before moving the work piece or changing settings.
- Blade adjustment is to be made only with the power off and the blade stopped.

- To reduce risk of injury, return the carriage to the full rear position after each crosscut operation.

- If using clamps, be sure they are tight before starting any operation.

- Support long work with an outboard tool rest.

- Allow motor to reach full speed before cutting. Stalling or partial stalling of motor can cause major damage.

### 5.1.8 Jig Saw (wood, metal, plastic)

![Jig Saw](image1.jpg) ![Jig saw Blades](image2.jpg)

The jig saw is a portable saw that has a reciprocating blade and can cut curves well in various materials. There are different types of blades for different materials, so check before using the saw that it has the appropriate blade and ask the instructor for help changing the blade if needed. Blades are usually packaged with appropriate uses listed. To cut metal it essential to use a slower speed on the blade movement so that the blade does not overheat and dull quickly. You may also need to use a oil coolant on the blade to keep the blade and metal being cut cooler and lubricated. The variable speed setting on the saw can be set to an appropriate speed. An advantage of the jig saw over the band saw is that it can be used to cut larger pieces of material that would not fit on the band saw and a hole can be drilled in the material the jig saw blade set in and an interior shape can be cut.
Doing an interior cut, first drill a hole that the blade can be set into, then begin cut.

**Jig Saw Safety**

Follow All Shop Safety Rules and always have Eye Protection
- Select the proper blade for the material to be cut, and secure the blade in the saw before plugging in the electric cord.
- Clamp or secure the stock being cut to prevent it from moving, do not hand hold small pieces.
- Hold the jig saw firmly against the work piece to prevent vibration or injury.
- If stopping in the middle of the cut, do not lift the saw and blade up out of the cut until the blade has stopped moving. If the blade is still moving as it is being lifted out it can hit the stock and bend, which will make it cut poorly and break sooner.
- Be careful not to cut into the table or support under the stock you are cutting, support overhanging material so it does not fall unexpectedly.

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**To Change Blade:**

1. Unplug saw
2. Pull knob on top of saw about 1/4”. Rotate knob counterclockwise about 3 full turns until blade clamp is open. (Illustration #2)
3. Pull blade out. (Illustration #3)
4. Insert new blade into open clamp. (Note: shoulder of T-shank blades do NOT slide into clamp.) Make sure back edge of blade rests in support. (Illustration #4)
5. Tighten clamp by turning top knob (still in up position) clockwise about three full turns. Clamp is secure once clicking sound is heard. (Illustration #5)
6. Push knob down. (Illustration #6)
A stationary saw where the blade is a band of metal with teeth. The teeth are similar to the teeth on a hacksaw blade. The speed at which the blade moves is set slower when cutting through metal than softer materials such as wood. If the blade speed needs to be changed ask the instructor to do it, do not adjust this on your own. The slower speed keeps the blade from overheating and damaging the blade or binding up as the stock expands from heat. A coolant is also applied to the blade and stock to keep it cool. The thicker the metal you are cutting, the more frequently you need to apply more coolant to the blade and stock. On the band saw the stock is is held against the table and then fed into the moving blade, keeping hands away from the blade. Curve cuts can be cut on the band saw but the curve should not be any tighter than the recommended curve listed on the machine for the width of blade being used. The following safety rules for using the band saw.

**Band Saw Safety Rules**

*Follow All Shop Safety Rules and always have Eye Protection*

- Keep all guards in place.
- Adjust the blade guards to within 1/8” to _” of the stock. Blade guards that are over an inch above the work will lead to accidents and reduces the accuracy of your cut.
- Maintain the stock flat on the table. the material must remain flat on the table surface at all times.
- Care must be taken when cutting round stock on the band saw. The round stock may roll into the blade causing an accident. Ask the instructor if you need to cut round stock—a jig (device for holding stock) may be needed.
- If the blade comes out of the guides or breaks, stop the machine immediately by turning off the power.
- Do not open the access door to the machine. Have the instructor reposition or install a new blade.
- Only back material out of a cut if it is a short and straight cut that will not bind up the blade, otherwise turn off the power and and wait for the blade to stop before backing the stock out of the cut.
- Always use a push stick when sawing small stock.
- Do not hold the stock with your hand(s) in line with the saw blade. Hold the stock to the sides of the cutting line. Keep your hands and fingers several inches from the moving blade.
- Use ‘relief cuts’ on tight curves to avoid breaking the blade.

5.1.10 HORIZONTAL BAND SAW (metal)

![Horizontal band saw with metal clamped in place.](image1)

The horizontal band saw has a hinged saw assembly mounted to a base with a stock clamp. The stock to be cut is clamped securely and the blade lowers and cuts through it. The blade can be lowered by adjusting the one of the valves on the hydraulic system that controls the lowering of the blade. The lever valve opens the system so the blade begins to drop, and the round dial controls the rate at which it will drop. Slower rates usually give straighter cuts. The horizontal band saw has an automatic coolant feed, if you do not see coolant flowing when the blade is running the coolant valve may be closed, pump switch...
may be off or the coolant tank may be empty. Ask the instructor for help if the coolant needs to be refilled.

**Horizontal Band saw Safety rules**

*Follow All Shop Safety Rules and always have Eye Protection*

- All work pieces must be secured in the machine’s clamp.

- The moveable jaw of the machine’s clamp pivots about its center. Thus if your work piece extends less than half way through the jaws of the clamp, you must use a spacer on the other side of the pivot in order to prevent slipping.

- Do not allow the machine to drop rapidly causing the blade to impact the work piece. Slowly lower the saw and let it gently engage the work piece.

- Do not push down on the top part of the horizontal band saw cutting head to make it cut faster, the weight of the machine will be enough and forcing it can damage the blade.

- If the coolant is not flowing when the saw and coolant switch and valve are on, inform the instructor immediately.

### 5.1.11 METAL SNIPS/SHEARS (metal)

Metal Snips are scissors like tools used to cut metal thin sheet. Aviation type come in 3 kinds, straight cutting/yellow handle grip, right curve cutting/green handle grips and left curve cutting/red handle grips. Maximum mild steel thickness is 18ga.
5.1.12 HAND SHEAR (metal)

For Cutting sheet metal.
-Hand Shear should be secured so it will not move when cutting.
-Do not try to cut material thickness greater than is listed on shear.
-Only cut rod in rod shear hole, Not in sheet shearing blade area.
-Keep fingers out of the way of the blades.

-Pull down handle to actuate the blade, be careful of hitting yourself with the handle at the end of the cut. Return the handle to an upright position so that it does not stick out into a walk way creating a hazard.

5.1.13 NIBBLER (metal)

The nibbler is a pneumatic cutting tool.
An air line is attached by a quick connection to the air intake on the tool.

The air line is turned on at the valve and regulator.

Follow All Shop Safety Rules and always have Eye Protection
- Add a drop of air tool oil to the air intake before using the tool and again if using the tool continuously for more than 20 min.

- Do not force the tool.

- Do not attempt cutting metal to thick for the tool, 18ga. max.

- Be careful of the sharp edges of the cut metal.
Follow the manufacturer's specifications as to gauge of sheet metal that can be safely cut. Our sheer can cut up to 16 gauge thick mild steel.

Keep fingers out of the way of the blade and clamp.

Do not cut round stock or anything except sheet metal in the shear.

Place the sheet against the guide, line up your cut mark with the blade and then press down on the foot pedal to get the clamp down and then continue pressing to shear the sheet.

Pick up the scrap pieces when you have completed cutting.
5.1.15 METAL PUNCH (metal)

The punch in the upper part of the tool is lined up with a corresponding sized die in the bottom and as pressure is applied through the handles a hole is punched through the metal sheet. Max. thickness of sheet 18ga.

5.1.16 Disc Cutter (metal)

Pneumatic tool using a bonded abrasive disc to cut through steel.

Follow All Shop Safety Rules and always have Eye Protection
-never remove guard.
-use air tool oil in air intake to keep tool lubricated. 1-2 drops at the beginning and again after continuous use.
do not force or twist disc in cut, disc can bind up causing the tool to jerk out of your hand unexpectedly.
-secure work in vice or with clamp.
5.2 Drilling

5.2.1 Drill Bits (wood, metal, plastic)

Twist Bits for wood, metal and Plastics

Spade bits for wood and plastics. Do Not Use on Metal

Drill Bits are used for making holes in material (Hole Saws are another device for this that are for larger holes). There are also special types of bits for masonry, stone, tile and glass.

- Be careful with thin bits, less than 3/32", as they can break if forced.
- Be careful of the side edges of twist bits as they are sharp as well as the point.

5.2.2 Hand Drill (wood, metal, plastic and other depending on bit)

Keyless and keyed chucks

Keyed chuck
Hand drill safety Rules

Follow All Shop Safety Rules and always have Eye Protection

- Clamp the work so it does not spin and cause injury or tool damage.

- Tighten the drill using the keyless chuck/chuck key and remove the chuck key immediately.

- Hold the drill motor firmly, and keep hands away from the revolving spindle and drill.

- Check to see that the drill is set to forward drilling.

- Apply straight and steady pressure on the drill as you pull the trigger, slower speed for steel than wood. Ease up on the pressure as the drill begins to break through the material.

- With the motor still running back out the drill as soon as the hole is drilled.

- Turn off the drill and hold firmly until it comes to a complete stop before laying it on the work bench.

- When using metal, you can use a center punch to make a divot where you want to drill that the bit can be set into, so the bit will be less likely to wander on the metal when starting the drilling.
5.2.3 DRILL PRESS(wood, metal, plastic)

The drill press is large drill mounted on a stand with a table for the work piece. The drill bit is mounted in the chuck and the chuck is moved towards the work piece by turning the side handle.

Follow All Shop Safety Rules and always have Eye Protection
- Check the drill press head and table for security and condition before starting.

- A center punch will help locate the hole to be drilled in the correct place.

- Select the correct speed for the material and size drill being used.

- Remove the drill chuck key immediately after tightening or loosening the chuck. If the drill press is turned on with the key in the chuck it can be thrown from the machine causing injury.

- All work pieces must be held securely for drilling. A drill vice or C-clamps can be used to secure the work. A work piece that moves when being drilled can break the drill, injure the operator and destroy the work piece.

- Hands are to be kept clear of the revolving spindle, chuck, drill and chips.

- Be sure the drill press is stopped before removing the work piece, chips or cuttings.
5.3 **Routering**

5.3.1 **Router Bits (wood)**

- Set of Router bits.
- Router bit installed in router.

5.3.2 **Router**

- Router.
- Groove made freehand with router.

**Router Safety**

*Follow All Shop Safety Rules and always have Eye Protection*

- clamp wood securely.
- turn off motor when not in use.
- disconnect plug when changing bits.
- hold tool firmly as to not lose control.
- turn power on only when in a working position, but keep bit clear of stock until it reaches full speed.
- the router bit revolves clockwise, therefore, when cutting straight edges, move the router left to right. When making circular cuts move router in counter clockwise direction.
5.4 Carving

5.4.1 Straight Wood Chisel (wood)
Chisel w/ flat cutting end, creating a flat cut

5.4.2 Gouge (wood)
Chisel with curved cutting end creating curved cut.

5.4.3 Wood Mallet (wood)
Tool used to hit the end of the chisel.
Wood Chiseling with a gouge and wood mallet.

5.4.4 Stone Carving Chisels w/ Pneumatic Hammer (stone,masonry)
Special chisels used to carve stone. Remember to put drops of oil in the air intake of the pneumatic hammer.

Safety in Carving
Follow All Shop Safety Rules and always have Eye Protection
-secure work with clamp or jig.
-never carve towards yourself, the chisel can cut or gouge you.
-do not force tools or use chisels as pry bars.
-use a wood or rubber mallet on a chisel with a wood handle, using a metal hammer can cause the handle to split damaging the tool and possible injury.
5.5  *Planing*

5.5.1  *Hand Plane (wood)*

Holding and moving the plane forward.  Blade set into plane and chips made by cutting action.

This Plane is for cutting the edges of wood to obtain a flat smooth edge.  Blade is adjusted to protrude out the bottom of the plane at an angle that allows cutting.  - Be careful not to touch sharp edge of blade.  
- Lay plane on side when not in use so as not to damage blade.

5.6  *Sanding/Grinding*

5.6.1  *Abrasive Paper (wood, metal and other)*

Abrasive Paper/ sand paper is used to remove material.  The paper, or backing material, can be a stronger woven fabric. The backing material has abrasive particles adhered to it. The different types of abrasive material are to abrade different types of materials. Alumina oxide is a general purpose abrasive for us on metal and wood.  Silicon carbide is a harder material for ceramic, glass and stone. The abrasives come in different particle sizes called grits.  Courser grits are used to remove larger amounts of material and leave a rough surface.  Medium and finer grits are used to smooth wood. The grit number stands for the number of particles per square inch., the lower the number the larger the particles and larger particle mean a courser paper.  60-80 grit are course, 120-150 medium and 220 and higher fine.

Safety in any sanding operation (including power) includes some form of dust and particle ventilation/dust mask/respirator.  Breathing in dusts from sanding can cause damage to the respiratory system.
5.6.2 Stationary Belt Sander (metal)

2” belt sander without work rest.  6” belt sander with work rest. 
Machines have belts that are coated with abrasives.

Wood can be used on these machines, but use the outside sander for wood when ever possible.

Follow All Shop Safety Rules and always have Eye Protection
-If using a work rest, Adjust to within 1/16 inch of the belt face.

-Do not allow hands to come in contact with the belt while it is in motion.

-Hold the work firmly, and make grinding contact smoothly with adequate but not excessive pressure. You should never push so hard as to loose control of the work or slow the belt to a stop.

-Never force work piece up at sharp angles against the direction of the belt.

-If using a work rest, keep the work piece securely against it.

-It is advisable to use a respirator/dust mask when creating particles and dusts.
5.6.3 Stationary Disc Sander (wood, metal)

When sanding wood, use the outside sander, when sanding metal use the inside grinder. Turn on dust collection system.

12" Disc Sander Safety
Follow All Shop Safety Rules and always have Eye Protection
- Keep hands away from moving disc and gap between disc and support table.
- Keep material down against support table.
- When just sanding on half the disc, check the rotation of the disc and sand on the side where the disc is running down towards the table so the force pushes the work piece down and not up at you.
- Hold the work firmly, and make sanding contact smoothly with adequate but not excessive pressure. You should never push so hard as to loose control of the work or slow the machine to a stop.
5.6.4 Portable Belt Sander (wood, metal)

Portable Belt Sander Safety
Follow All Shop Safety Rules and always have Eye Protection
-keep hands and fingers away from moving belt.
-Secure work in vise or with clamp.
-Turn off sander if belt moves off center.
-Do not let go of sander while it is on.

5.6.5 Random Orbital Sander (wood, metal, plastic)

The random orbital sander oscillates as it spins and is generally for finish sanding. If tingling in hands or wrists becomes noticeable, take brakes from using to limit the continuous exposure to tool vibration.
Follow All Shop Safety Rules and always have Eye Protection
5.6.6 Disc Sander/Grinder (wood, metal, masonry)

Grinder/sander with 7" sanding disc attached. Grinder with 4 ½" grinding disc.

Disc grinder/sanders have removable discs. A sanding disc with back-up pad can be used on wood, metal and masonry. There are different grits for coarse to fine sanding. These discs will dull as they get used. A grinding disc can be used with metal or masonry (check the disc to see which material it is made for). Grinding discs are made of bonded abrasives, alumina oxide is commonly used for metal and silicon carbide for masonry. Grinding discs will wear down and need to be changed when they get to small to use. Only use a disc that is rated for the RPMs of the tool (written on the tool). We have a larger grinder that is designed for 7" discs and smaller grinders for 4 ½" discs. Make sure the disc is correctly attached before turning on the tool, have instructor change discs if you have not been shown how or are unsure.

When grinding, have the disc make contact with the material to be ground at a approximately. 15 degree angle.
When grinding metal, be aware of the sparks. Small fragments a metal, hot enough to glow and moving fast. Watch that you are not sending them towards flammables or people.

Disc Sander Safety
Follow All Shop Safety Rules and always have Eye Protection
- Secure work with clamp or vise
- Use front edge of disc to sand, do not put spinning disc flat against the work.
- When stopping use of tool and setting down, set down with disc up to prevent tool from moving if accidental starting should occur.
- Do not remove guards.

5.6.7 Die Grinder (wood, metal)

Also known as straight and rotary grinder (wood, metal)

Can be used with other materials depending on the accessory tooling
Pneumatic die grinder showing 1/8" collet, ¼" collet and retaining nut.

The correct sized collet is chosen for the tooling shank to go in the grinder and it is inserted and the retaining nut threaded on and tighten. Do not tighten excessively. Use proper sized wrenches, improper sized wenches or pliers will strip the nut and shaft, over time ad make it difficult to tighten or loosen the tool.

Small burrs w/ 1/8" shank. Large burrs and mandrels w/ ¼" shank.

Burrs are grinding tools for die grinders. There are also sanding cones and discs and cutting discs to be used with the proper mandrel (tooling that holds the disc or cone that are designed to be used with die grinders. Use only tools that are rated for the RPMs of the grinder.

Other types of rotary grinding tools that use burrs are flexible shaft machines with the motor separate from the tool holder.

Follow All Shop Safety Rules and always have Eye Protection
-do not force or jamb tool into work.
-secure work with vice, clamp or sand bag.