***General Safety***

There are several safety measures you must take to protect yourself from shop hazards. For example, do not wear the following when working around machinery:

1) Loose fitting clothing

2) Neckties

3) Jewelry

4) Long loose hair

If you must wear a long sleeved shirt, be sure the sleeves are rolled down and buttoned. Snug fitting clothes and closed toe shoes are essential safety equipment in the shop.

Always wear safety glasses with side shields when in the shop, regardless of whether or not power tools are currently being used.

Additional protection using goggles or face shields may be necessary for grinding and other operations that produce sparks and/or large amounts of high-velocity debris.

Before beginning work in a shop, be sure you are authorized to perform the work to be done and inspect your tools and equipment. If a procedure is potentially hazardous to others in the area, warn fellow workers accordingly.

Maintain good housekeeping standards.

Keep the work area free from slipping/tripping hazards (oil, cords, debris, etc.).

Clean all spills immediately.

Remove sawdust, wood chips, and metal chips regularly with a broom or vacuum – never your hand.

Hot metal looks like cold metal. Do NOT touch parts that were recently cut, sanded, or ground– you can and will get burned!

Know where fire extinguishers are located and how to use them.

To use a power tool without supervision, you must have passed its associated tests, both written and demonstration.

Before the last person leaves the build site, a facilities inspection is to be completed and a safety sheet must be filled out.

***Hand Tools***

Use the right tool for the right job.

Wear safety glasses whenever you hammer or cut, especially when working with surfaces that chip or splinter.

Do not use a screwdriver as a chisel.

Do not use a chisel as a screwdriver.

Do not use a knife as a screwdriver.

Never carry a screwdriver or chisel in your pocket. If you fall, the tool could cause a serious injury. Instead, use a tool belt holder or tool box.

Replace loose, splintered, or cracked handles. Loose hammer, axe, or maul heads can fly off defective handles.

***Drill Press***

Use a center punch to score the material before drilling to ensure hole accuracy.

When drilling large (.3125 and above) holes, a center punch is not sufficient to ensure accuracy. Instead, a pilot hole should be drilled with a smaller bit before drilling to the desired size. If the hole is especially large, several steps of pilot hole size may be required.

Never attempt to loosen or tighten the chuck unless the power is off.

Remove chuck key before starting the drill.

Never use a bit with a broken tip.

Run the drill at the correct speed. Forcing or feeding too fast can break drill bits. Larger bits or harder materials need slower speeds.

Metal and wood being drilled with large bits should be clamped to prevent binding and spinning.

Frequently back the drill out of deep cuts to clean and cool the bit.

Use cutting oil when drilling steel or large/deep holes in aluminum.

Do not attempt to slow the chuck, let it slow to a stop after turned off.

If the bit binds in the material being drilled, turn off the press and turn the chuck backwards by hand to free the bit.

Use a broom/brush or vacuum to remove waste – never remove material with your hand.

***Power Hand Drill***

Hand drills are in general less precise than drill presses, and so should only be used in situations where it is impossible/inconvenient to use a drill press – i.e. when drilling a hole on an already assembled part of the robot.

Use a center punch to score metal before drilling.

Never attempt to loosen or tighten the chuck unless the power is off.

Remove chuck key before starting the drill.

Never use a bit with a broken tip.

Metal and wood being drilled with large bits should be clamped to prevent binding and spinning.

Hold the drill firmly and perpendicular to the part.

Press the drill firmly into the material being drilled.

Frequently back the drill out of deep cuts to clean and cool the bit. Use oil when drilling metal.

Do not attempt to slow the chuck, let it slow to a stop after turned off.

If the bit binds in the material being drilled, release the trigger and turn the chuck backwards by hand to free the bit.

When not drilling, the drill should be stored lying down.

***Grinder***

Wear face shield when grinding.

Only grind steel items. (Use sander for aluminum)

Place the grinder tool rest 1/8 inch from the wheel and slightly above the center line.

Allow the grinder to reach full speed before stepping into the grinding position.

Use a vise-grip plier or clamp to hold small pieces.

Slowly move work pieces across the face of wheel in a uniform manner. This will keep the wheel sound.

If the piece becomes uncomfortably hot, use gloves and dip the part in water or other coolant.

***Sander (Belt & Disk)***

Ensure that sanding belts are not too tight or too loose.

Do not use a sander with ripped sand paper.

Ensure that the distance between a circular sander and the edge of the table is not greater than 1/4 inch.

Do not push materials against sanders with excessive force.

Move material back and forth across sander, never hold material in one place.

Only sand on the down stroke side of a disk sander.

Do not hold small pieces by hand. Use a jig or vice grips for pieces that are difficult to hold securely.

Keep power cord away from sanding surfaces.

If the belt sander tears while you are using it, immediately turn off the sander. Replace the belt, and consider using a hand file to sand the part if you suspect a particularly sharp edge caused the tear.

Sweep dust from work area after sanding. Use a vacuum to remove dust from the sander itself.

***Band Saw***

Set the blade evenly with the proper amount of tension.

Only cut steel with the band saw when there are no other options!

Set the blade guard to approximately ¼ inch above the height of material being cut.

Allow blade to come up to speed before attempting to cut.

Keep your hands on either side of the cut line. Never reach across the cut line for any reason. Keep your fingers at least an inch, preferably more, from the blade.

Do not attempt to cut sharp corners – make a series of relief cuts, or use the perpendicular curve method if the angle is interior, to cut small corners (or cut a general shape and sand to final shape).

If blade binds, breaks, or comes off the wheels – immediately turn off the band saw.

When done, turn off the saw and wait for blade to come to a complete stop before removing material or cleaning the work table.

Use a broom or vacuum to remove small scrape and dust from the saw.

***Cut-off (Miter) Saw***

Use the correct blade for the material – normal tooth for wood, fine tooth for aluminum, and abrasive cut-off for steel. Unplug the saw when changing the saw blade.

If cut is perpendicular, hold material firmly while cutting. If cut is an angle and wood, hold firmly. If the cut is an angle and the material is metal, clamp material while cutting.

Wear a face shield while cutting steel.

Make sure all adjustments (for angle cuts) are tight before cutting.

Do NOT cut any parts smaller than 4”-5” on the miter saw. If your hand feels too close, it probably is!

Allow saw to reach full speed before starting cut.

Push saw blade at a constant rate through material without straining the motor. Cut all the way through the material and bring the saw back up before turning saw off.

Wait for saw to come to a complete stop before moving material or reaching under saw.

Clean saw with a broom or vacuum after cutting is done.

***Dremel***

Use the right type of bit for the right job. Ask for help choosing bits.

Make sure the bit is tight in the chuck.

Use proper speed for the job – fast for grinding, fast/medium for cut-off, slow for polishing.

Material must be firmly in place (attached to robot, in a vise, etc.).

Allow dremel to get up to speed before starting to use.

Grip the dremel firmly with both hands. Use a table or robot frame to rest your arm or body against while working to gain stability.

Apply gentle to moderate pressure; NEVER try to force the dremel into the material.

If the dremel jerks or spins away from you when cutting, hold it more firmly and consider bracing your arm or elbow against the table.

The bit should spin away from you so material cut or broken bit pieces would fly away from you.

When using the cutoff wheel, the wheel can be broken easily if it is shifted to an angle different then the original cutting angle. To avoid this, ensure that a constant angle is maintained throughout the cut.

If cutting steel, wear a face shield.

Keep the power cord away from work area to prevent accidentally cutting it.

When all done, remove the bit from the dremel and return both to the proper storage location.

***Scroll Saw/Jigsaw***

Jigsaws are generally used to cut large, complex shapes, like curves.

Use the right blade – check to make sure you’re cutting wood with a wood blade.

Check to make sure the blade is fully tightened before use.

Make sure the cutting line is fully drawn out and visible.

If doing a cutout cut, drill holes large enough for the blade before cutting.

Ensure the material is far enough off of the ground.

Ensure the blade travels far enough that it will cut all the way through the material.

Ensure the saw table is flush against the material at all times.

Ensure that the waste material is also propped, so it does not sag and shift the cut.

When cutting, do not rush. Moving too quickly creates a rough cut edge, and can damage the tool. It is also difficult to maintain accuracy when moving too fast. However, do not go too slow, either. Your arm will get tired faster than you realize!

When cutting, if your arm gets tired from vibrations, it is ok to stop and rest for a bit. It’s better to rest when you need to than hurt yourself and damage the part!

***Circular Saw***

Circular saws are used to perform long, straight cuts in wood. They should not be used to cut metal.

When possible, it is advisable to use a fence to ensure a straight cut.

Ensure that the blade is not touching the material when you begin to cut.

If not cutting all the way across the material, remember that since the blade is circular, the cut will be shorter on the bottom than on the top. Cut a bit past your desired endpoint to make sure that the entire blade made it all the way.

If the blade binds, you should back off a bit, then try to correct the angle of the blade so it goes straight.

When cutting, the saw table should always be flush to the material.

Adjust the depth of the blade so that it cuts approximately ½” more than the thickness of the material being cut.

When cutting, always ensure the material is high enough off of the ground.

When performing a plunge cut, take extra care to ensure the angle of the saw is correct. Pull the guard back all the way, set the blade on the cut line, power on and slowly lower the blade through the material. Proceed to cut normally.