



Student's Machine Shop Handbook & Best Practices

GENERAL NOTES

- A. Each machine that you use must be brushed off and wiped down as you finish using it, or at the end of each day. This includes the bases of the machines.
- B. If you should happen to break a tool or damage a machine, let the shop technicians know so that it can be repaired or replaced.
- C. No horseplay or loitering in the shop. Distractions cause mistakes and accidents.
- D. For safety when working in the shop, practice the "buddy system". Be sure that at least one of your colleagues / "buddies" or another shop staff member knows what you're working on and is within earshot, in case you call for help.
- E. Work must be stopped by 3:15pm daily for cleanup, unless otherwise arranged with shop staff in advance.
- F. Let the shop technicians know what materials in the shop you need for your projects so that a current inventory can be maintained.
- G. No personal jobs in the shop.
- H. If you are not sure about something, **ASK FIRST**.
- I. Be careful if using air hoses to clean any lathe or mill. If used incorrectly, compressed air can blow debris into your eye or someone else's around you.
- J. When using the belt sander, don't force parts into the sander, especially sharp edges. Hold parts securely while sanding and apply steady, controlled pressure against the belt to allow it to remove material, without ripping the belt..
- K. On the small bandsaw, set the speed at 150 FPM for steels and not above 350 FPM for brass, aluminum, or plexiglass. **If unsure, ask a Technician/Shop Mgr. for assistance, we'd be happier to help you first, rather than replace a broken saw blade later.**

- L. The stand grinders are identified as to what they can be used for. Never grind aluminum or brass on them. Instead, use the belt sander for this purpose.

TOOLS

There is a student tool box located in the shop. These are available for all students to use. If you intend to keep the tools out for an extended period of time, please check with the Shop Technicians first & complete the "Tool Checkout" online form (see Technician's or Shop Mgr. for this form). Do not use tools from any other tool boxes without permission from Shop Technicians. Remember, the tools in the student box are used by all of the students. Handle them carefully and place them back in the correct spot in the toolbox when done.

SHOP MATERIALS

The following materials are available for purchase in the shop:

- Aluminum
 - Round Stock (6061-T6 & some other alloys)
 - Sheet & Plate (6061-T6 & some other alloys)
- Steel
 - Round Stock (12L14, 1018, 4140/4130 & some other alloys)
 - Flat Stock (1018, A36, HR & CD, some other alloys)
- Brass
 - Round Stock (Free machining naval brass)
 - Flat Stock (Free machining naval brass - limited amount)
- Plastics
 - Round & Sheet
 - Acrylic "i.e. Plexiglass" & Polycarbonate "i.e. Lexan"
 - Nylon & Teflon - Round Stock odds & ends
 - Rubbers/Gasket Material – odds & ends
- Stainless Steel (304 & 316)
 - Sheet, Round stock, plate
 - Limited amount of odds & ends
- Wood
 - Limited amount of odds & ends (lumber, plywood, OSB)

- University Stores stocks structural steel such as angle, flat strap, channel, square tube, and pipe.

GENERAL RULES

- A. Clean machines and the floor after you use them. The large "Shop Vac" works very well for this. There are also a set of brooms and dustpans in the small closet by the electrical breaker panel on the East wall.
- B. If you aren't sure of a "set up"/work-holding in a machine, ask before beginning work for safety purposes as well as machine and material damage.
- C. Always replace tools, where you found them. Leave them CLEAN and in good condition.
- D. Do not wear loose clothing - roll up long sleeves. Always remove all jewelry before working with tools and equipment. Never wear gloves while operating any machine. Long hair should be tied in a safe manner.
- E. Wear safety glasses or a face shield. The bookstore has inexpensive glasses for non-eye-glass wearers. We have either safety glasses or goggles in the shop. We also have disposable side shields for prescription glass wearers.
- F. Be thoughtful and helpful toward others in the shop. Bring any safety violations to the attention of the shop personnel in a courteous & professional manner. Please no "tattling" on your peers.
- G. Select the proper size and type of tool for your work. Inform a Shop Technician if tools are broken, have loose handles, or need adjustments. If you can't find what you need, **ASK**, we'd be happy to help.
- H. Keep edged and pointed tools turned down and away from you as well as others. Do not carry sharp tools in your pockets.
- I. Whenever possible, mount the work in a vise, clamp, or special holder.
- J. Hold a tool in the correct position while using it. Most edged tools should be held in both hands with the cutting motion away from yourself and other students.

- K. Do not "rush or tear" through your work. A steady, unhurried pace is safest and will produce the best results, with fewest mistakes.
- L. The floor should be clear of scrap blocks and excessive litter. Immediately wipe up any liquids spilled on the floor. Ask Shop Manager or a Technician about proper disposal methods for various chemicals.
- M. Report all injuries to a Technician or the Shop Manager immediately.
 - a. If a student is injured, he/she can be taken to Student Health.
 - b. Faculty and staff must be taken to the hospital.
 - c. All eye injuries should be taken to the hospital.
- N. Stop the machine to make adjustments or measurements. Never touch the machined surface while the machine is still running. Be careful, machined surfaces can be HOT & SHARP.
- O. **NEVER ATTEMPT TO REMOVE CHIPS OR CUTTINGS WITH YOUR HANDS, OR WHILE THE MACHINE IS RUNNING.** Use a brush or pliers (needle nose) to remove long, stringy chips from the lathe.
- P. Use ear protection on noisy machining and manufacturing operations.

SAFETY TIPS FOR INDIVIDUAL MACHINES

A. Lathe

- 1) Wear eye protection.
- 2) Clamp all work solidly. Use the correct size tool or work holding device for the job. Get help if you must use heavy chucks or attachments. Use a board laying across the ways when changing chucks. This will protect your fingers as well as the lathe bed. Keep as short a "reach" as possible on the tool bit holder to prevent tool deflection, improving both safety and machining accuracy of your part.
- 3) Turn the chuck or faceplate by hand to be sure there is no binding or danger of the work striking any part of the lathe. Do this after installing work piece and **BEFORE** starting lathe.
- 4) Stop the machine & de-energize the drive motor (when feasible) before making adjustments or measurements. An energized spindle with your hands in the way

will cause serious injury!

- 5) **NEVER leave the key (T-handle) in the chuck.** If you don't remove the chuck key and turn on the spindle, the key will be launched across the shop or smashed into the ways, causing bodily injury and likely equipment damage. **Make it a habit never to let go of the key until it is out of the chuck and clear of the work area.**
 - i) *If this is a recurring problem for you, we will be having a frank conversation with consequences up to and including losing your privilege to use the shop. Please take this seriously.*
- 6) Remember that the chips are **razor sharp**. Do not attempt to remove chips with your fingers. Stop machine and use pliers or wooden brush to remove them.
- 7) Support all work solidly. **Do not permit small diameter work to project too far from the chuck without support from the tailstock center or a roller stand on the outside of the thru-bore.** This can cause material to "whip", which is very dangerous and can cause material to loosen or be thrown from the chuck if left uncorrected.
- 8) Be careful not to run the cutting tool into the chuck or lathe dog. It is a good idea to feed away from the chuck, if possible, until you're familiar with the machine.
- 9) Never attempt to run the chuck on or off the spindle by using power. It is also a dangerous practice to stop the lathe by reversing its direction of rotation.
- 10) You should always be aware of the direction and speed of the carriage or cross-feed before engaging automatic feed. A simple method is to position the carriage a safe distance from your work and "pre-trial" it before the actual cut is made.
- 11) Tools must not be placed on the lathe ways. Instead, place them in a safe location, like up on the flat area with rubber-matting of the headstock.
- 12) Never use a file without a handle. The metal tang is sharp and can stab into your hand causing serious injury.
- 13) Stop the machine immediately if some odd noise or vibration develops while you are operating it. Notify a Technician or the Shop Manager immediately.
- 14) Plan your work thoroughly before starting. Have all of the tools that will be needed at hand before commencing work. You should have some kind of a

drawing of the part you are making & have discussed it with shop staff, prior to beginning work.

15) Clean lathe with brush or "Shop Vac." Be very careful if using air hoses for routine cleanup to not blow a chip into your eye or your neighbors.

B. Mill

- 1) Wear eye protection.
- 2) Get help to move any heavy attachment like the vise, dividing head, rotary table, etc.
- 3) Use a brush to remove chips - NEVER brush with your hand.
- 4) Stop the machine before attempting to remove chips.
- 5) Never reach over or near the rotating cutter.
- 6) Make sure the holding device is mounted solidly to the table and the work held firmly.
- 7) Be thoroughly familiar with the STOP lever.

C. Pedestal Grinder & Deburring Wheels

- 1) Wear eye protection.
- 2) Keep hands clear of the rotating grinding wheel.
- 3) Make sure the tool rest is properly adjusted, but never adjust it while the machine is running.
- 4) Never force work against the grinding wheel. Instead, apply a steady, even pressure, feeding the work into the wheel.

D. Sheet-metal Shear

- 1) Wear eye protection.
- 2) Keep fingers away from cutter. If it will cut off sixteen gauge metal, it will cut off your finger!
- 3) Cut soft metals up to sixteen gauge (1/16") only.
- 4) Pick up your scraps from the floor and deposit in correct metal recycling bin.

E. Drill Press

- 1) Wear eye protection.
- 2) Check the speed setting to see that it is correct for your work. Holes over ½ inch should be drilled at the lowest speed. Also countersink at slow speed.
- 3) Mount the bit securely to the full depth of the chuck and in the center. Remove the key immediately.
- 4) Position the table and adjust the feed stroke so there is no possibility of the bit striking the table. The work should be placed on a wood pad when holes will go all the way through.
- 5) **CLAMP THE WORK SOLIDLY.** Do not hold it with your hands. A "merry-go-round" can inflict serious and painful injury. Small or irregular shaped pieces must be clamped to the table or held in some special fixture.
- 6) Feed the bit smoothly into the work. When the hole is deep, withdraw it frequently to clear the chips and cool the bit, this is called "pecking" the drill hole.
- 7) Let the drill spindle stop on its own accord after the power has been turned off. Do not try to stop it with your hand.
- 8) After using the drill, wipe it clean of chips and cutting fluid before putting away.

F. Band Saw

- 1) Wear eye protection.

- 2) Adjust the upper guide assembly so it is 1/4 inch above the work.
- 3) Allow the saw to reach full speed before starting to feed the work.
- 4) The stock must be held flat on the table.
- 5) Feed the saw only as fast as the teeth will remove the material easily. Don't force material into the blade if it doesn't seem to be cutting easily.
- 6) Get help when cutting heavy material.
- 7) Stop the machine before making adjustments.
- 8) Maintain a 2 inch margin of safety. Keep your hands clear of all moving parts and use a "pusher"/sacrificial block of wood or scrap Aluminum to push your part through the saw.
- 9) ALWAYS stop machine on LOW speed.
- 10) Use proper speeds for material being cut. When cutting iron, run machine on slow speed. Stainless steel requires a fine tooth blade. Ask the Shop Technicians about this.
- 11) Do not try to cut too small a curve as it will bind the blade and take the set out of one side of the blade.

G. Woodworking Tools

(See EERB Innovation Wyrkshop "Makerspace" to use woodworking tools yourself. Our shop will do some wood-working for students, but we don't train students over here to use those tools anymore)

- 1) The Makerspace in the EERB building has a complete and safer, more modern set of wood-working power tools and streamlined training program, including:
 - i) SawStop table Saw
 - ii) DeWalt Compound Sliding Miter Saw
 - iii) Wood Routers
 - iv) Wood Lathe
 - v) Laser Cutters capable of handling wood materials

- vi) Basic Safety Course, followed by specific training badges for the Woodworking area

H. Portable Electric Drills

- 1) Use eye protection.
- 2) Select the correct drill or bit for your work and mount it securely to the full depth of the chuck.
- 3) Stock to be drilled must be held in a stationary position so it cannot be moved during the operation. Use a pedestal or bench mounted vise for holding your work.
- 4) Turn on the switch for a moment to see if the bit is properly centered, running true & rotating the right direction.
- 5) During the operation keep the drill aligned with the direction of the hole.
- 6) When drilling deep holes, especially with a twist drill, withdraw the drill several times to clear the cuttings ("pecking" the drill hole).
- 7) Always remove the bit from the drill as soon as you have finished your work and put it back where it goes.

I. Saber Saw (Reciprocating / "Sawzall" saw)

- 1) Use eye protection.
- 2) Select the correct blade for your work (metal, bi-metal, wood, etc...) and be sure it is properly mounted.
- 3) Disconnect the saw to change blades or make adjustments.
- 4) Make sure the switch is OFF or the trigger is not pulled before plugging it in.
- 5) Place the base of the saw firmly on the stock before starting the cut.

- 6) Turn on the motor before the blade contacts the work.
- 7) Do not attempt to cut curves so sharp that the blade will be twisted. Follow procedures described for band saw operation (F).
- 8) Make certain the work is well supported and do not cut into sawhorses, tables, or other supports being used.

J. Combination Disk and Belt Sander

- 1) Use eye protection.
- 2) Be certain the belt or disk is correctly mounted. The belt must track in the center of the drums and platen. Do not operate the disk sander if the abrasive paper is loose.
- 3) Small and irregular-shaped pieces should be held in a hand clamp or some special jig or fixture.
- 4) When sanding the end grain of narrow pieces on the belt sander, always support the work against the table. Otherwise, the piece can be pulled out of your hands and forced between the belt and table. This is an ugly situation, so be sure to hold your piece tightly and don't lose control of your work.
- 5) Sand ONLY on the side of the disk sander that is moving down toward the table. Otherwise, the disk may try to pull the material up out of your hand. Move the work back and forth along this surface so it will not burn or wear a pattern into the disk.
- 6) Always use a pad or push block when sanding thin pieces on the belt sander.
- 7) Sand only clean, new wood. Do not sand work that has excess glue or finish on the surface. These materials will load and foul the abrasive.

WELDING SAFETY

(General Informational use only, welding to be done by shop staff. Exceptions for students who've completed a collegiate/SkillsUSA welding certificate program)

A. Safety precautions for Arc Welding

- 1) Make sure your arc welding equipment is installed properly, is grounded and is in good working condition.
- 2) Always wear protective clothing suitable for the welding to be done.
- 3) Always wear proper eye protection when welding, grinding, or cutting.
- 4) Keep your work area clean and free of hazards. Make sure that no flammable, volatile, or explosive materials are in or near the work area.
- 5) Handle all compressed gas cylinders with extreme care. Keep caps on when not in use.
- 6) Make sure that compressed gas cylinders are secured to the wall or to other structural supports.
- 7) When compressed gas cylinders are empty, close the valve and mark the cylinder "empty."
- 8) Do not weld in a confined space without extra special precautions.
- 9) Do not weld on containers that have held combustibles without taking extra special precautions. i.e. chemical tanks or old gas cans/tanks
- 10) Do not weld on sealed containers or compartments without providing vents and taking special precautions. i.e. chemical tanks or old gas cans/tanks
- 11) Use mechanical exhaust at the point of welding for lead, cadmium, chromium, manganese, brass, bronze, zinc, or galvanized steel.

- 12) When it is necessary to weld in a damp or wet area, wear rubber boots and stand on a dry, insulated platform.
- 13) If it is necessary to splice lengths of welding cable together, make sure all electrical connections are tight and insulated. Do not use cables with frayed, cracked, or bare spots in the insulation.
- 14) When the electrode holder is not in use, hang it on brackets provided. Never let it touch a compressed gas cylinder.
- 15) Dispose of electrode stubs in proper container. Stubs on the floor are a safety hazard.
- 16) Shield others from the light rays produced by your welding arc.
- 17) Do not weld near degreasing operations.
- 18) When working above ground, make sure that scaffold, ladder, or work surface is solid.
- 19) When welding in high places without railings, use safety belt or a lifeline.
- 20) When using water-cooled equipment, check for water leakage.

B. Safety Precautions for Oxyacetylene Welding and Cutting

- 1) Make sure that all of your gas apparatus shows UL or FM approval, is installed properly, and is in good working condition. Make sure that all connections are tight before lighting the torch. Do not use a flame to inspect for tight joints. Use soap solutions to detect leaks.
- 2) Always wear protective clothing suitable for welding or flame cutting.
- 3) Keep work area clean and free from hazardous materials. When flame cutting, sparks can travel 30-40 feet. Do not allow flame cut sparks to hit hoses, regulators, or cylinders.
- 4) Handle all compressed gas cylinders with extreme care. Keep cylinder caps on when not in use.

- 5) Make sure that all compressed gas cylinders are secured to the wall or to other structural supports. Keep acetylene cylinders in the vertical position.
- 6) Store compressed gas cylinders in a safe place with good ventilation. Acetylene cylinders and oxygen cylinders should be kept apart.
- 7) When compressed gas cylinders or fuel gas cylinders are empty, close the valve and mark the cylinder "empty."
- 8) Consult with shop personnel before welding in a confined space.
- 9) Consult with shop personnel before welding on any containers that may have held combustibles.
- 10) Consult with shop personnel before welding on sealed containers or compartments that are not properly vented.
- 11) Never use oil, grease, material, apparatus or threaded fittings in the oxyacetylene or oxy-fuel gas system. Oil and grease in contact with oxygen may cause spontaneous combustion.
- 12) Treat regulators with respect. Do not turn valve handle using force.
- 13) When assembling apparatus, crack gas cylinder valve before attaching regulators (cracking means opening the valve on a cylinder slightly, then closing). This blows out any accumulated foreign material. Make sure that all threaded fittings are clean and tight.
- 14) Always use this correct sequence and technique for lighting a torch:
 - i) Open acetylene cylinder valve.
 - ii) Open acetylene torch valve 1/4 turn.
 - iii) Screw in acetylene regulator adjusting valve handle to working pressure (5psig).
 - iv) Turn off acetylene torch valve (you will have purged the acetylene line).
 - v) Slowly open oxygen cylinder valve all the way.
 - vi) Open oxygen torch valve 1/4 turn.
 - vii) Screw in oxygen regulator screw to working pressure(30psig)
 - viii) Turn off oxygen torch valve (you will have purged the oxygen line).
 - ix) Open acetylene torch valve 1/4 turn and light with lighter (only use friction type lighter or lighting device provided).

- x) Open oxygen torch 1/4 turn.
 - xi) Adjust to neutral flame.
- 15) Always use this correct sequence and technique of shutting off a torch:
- i) Close acetylene torch valve first, then close oxygen torch valve.
 - ii) Close cylinder valves - the acetylene valve first, then the oxygen valve.
 - iii) Open torch acetylene and oxygen valves (to release pressure in the regulator and hose).
 - iv) Back off regulator adjusting valve handle until no spring tension is felt.
 - v) Close torch valves.
- 16) Use mechanical exhaust at the point of welding when welding or cutting lead, cadmium, chromium, manganese, brass, bronze, zinc, or galvanized steel.
- 17) If you must weld or flame cut with combustible or volatile materials present, take extra precautions, make out hot work permit, and provide for a lookout, etc...
- 18) Consult with shop personnel before welding or flame cutting on containers that may have held combustibles.
- 19) Consult with shop personnel before welding or flame cutting into sealed containers or compartments that are not vented.
- 20) Consult with shop personnel before welding or cutting in a confined space.

PROTECTIVE CLOTHING

Protective clothing must be kept in good repair. It must be kept dry. Hard hats should be checked occasionally and free of cracks or other damage. Gloves should be clean and not oily. Welding helmets should be checked occasionally for cracks, and filter glasses/lens should be replaced if damaged. Side shields for safety glasses should be used and safety glasses in welding areas should preferably be tinted.

DRILLING

A. General Notes:

- 1) Use cutting oil whenever possible when drilling. Use Cimcool coolant when drilling plexiglass.

- 2) Use negative-rake drills for drilling brass and plexiglass. There are a special set of drills labeled "For Plastics" in the tool room, which have been carefully dulled for this use, to prevent the bits from pulling into the material too fast.
- 3) Make sure the part is clamped securely before drilling.
- 4) Use a center drill to start a centered, accurate hole before drilling.
- 5) Below is a chart showing approximate speeds (SFM) for drilling various materials:

<u>Material</u>	<u>Cutting Speed (SFM)</u>
Low Carbon Steel	80-110
Stainless Steel	30-40
Cast Iron (Soft Grey)	100
Brass	200
Aluminum	200-300
Plastics	100-150

REAMING - Use approximately 1/2 of the drilling speed for the same size reamer. Reamers available in inch & metric step sizes, as well as some variable diameter reamers in the tool room.

TAPPING HOLES

A. General Notes:

- 1) Refer to wall or online charts for drill sizes.
- 2) Always use cutting oil or tapmatic whenever possible. Tap cast iron dry.
- 3) When tapping plexiglass, use the Cimcool coolant or the DoAll wax.
- 4) Use a tapping guide block whenever possible.
- 5) When tapping blind holes, back the tap out of the hole often to clear the chips from the tap.

LATHES

A. General Notes:

- 1) **Never leave the chuck key in the chuck.** If you don't remove the chuck key and turn on the spindle, the key will be launched across the shop or smashed into the ways, causing bodily injury and equipment damage. **Make it a habit never to let go of the key until it is out of the chuck and clear of the work area.**
 - i) *If this is a recurring problem for you, we will be having a frank conversation with consequences up to and including losing your privilege to use the shop. Please take this seriously.*
- 2) Use cutting lubricant to aid in cutting and prolong tool life whenever possible.
- 3) If you are wearing long sleeves, roll them up.
- 4) If you need a tool sharpened, check with the shop technicians for assistance.

B. Below is a chart showing approximate speeds (SFM) for turning various materials:

<u>Material</u>	<u>Rough Cut</u>	<u>Finish Cut</u>
Low Carbon Steel	90	100
Stainless Steel	60	80
Cast Iron (Soft Grey)	50	80
Brass	150	300
Aluminum	200	300
Plastic	100	250

MILLING

A. General Notes:

- 1) **Never leave the wrench on the draw bar.** If left on the drawbar, when you turn the spindle on, the drawbar spins and will launch the wrench across the shop!!!
 - i) *If this is a recurring problem for you, we will be having a frank conversation with consequences up to and including losing your privilege to use the shop. Please take this seriously.*
- 2) Always use a brush to remove chips. Never get your hands close to the cutter when it is moving.
- 3) Use cutting lubricant to aid in cutting and prolong cutter life.

B. Below is a chart showing approximate speeds (SFM) for milling various materials:

<u>Material</u>	<u>Rough Cut</u>	<u>Finish Cut</u>
Low Carbon Steel	75	90
Stainless Steel	55	75
Cast Iron (Soft Grey)	60	80
Brass	150	250
Aluminum	200	400
Plastic	150	160

After careful study of this handbook, please visit the following link to complete our Shop Safety Assessment & Acknowledgement Form:

<https://form.jotform.com/uwyoshop/shop-safety-assessment>