

**UNIVERSITY OF WYOMING**  
**COLLEGE of ENGINEERING**  
**STUDENT'S MACHINE SHOP HANDBOOK**

**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. The shop is closed at 5:00 p.m. for cleanup.
- E. Let the shop technicians know what materials in the shop you need for your projects so that a current inventory can be maintained.
- F. No personal jobs in the shop.
- G. If you are not sure about something, **ASK FIRST**.
- H. Do not use air hoses to clean any lathe or mill.
- I. When using the belt sander, don't force parts into the sander, especially sharp edges. Hold parts securely while sanding.
- J. On the small bandsaw, set the speed at 150 FPM for steels and at 375 FPM for cutting brass, aluminum, or plexiglass.
- K. The stand grinders are identified as to what they are intended to be used for. Never grind aluminum or brass on them. 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. 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. Return them to the proper place and handle them carefully.

## SHOP MATERIALS

The following materials are available in the shop:

Aluminum -	Round Stock (6061-T6) Sheet & Plate (6061-T6)
Steel -	Round Stock (12L14) Flat Stock (1018)
Brass -	Round Stock (Free machining naval brass) Flat Stock (Free machining naval brass - limited amount)
Plexiglass -	Round & Sheet (limited amount)
Stainless Steel -	Limited amount of odds & ends
Nylon & Teflon -	Round Stock
Wood -	Limited amount of odds & ends

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

## GENERAL RULES

- A. Clean machines and floor after you use them. The large "Shop Vac" works very well for this. \*Do not use compressed air to clean machines or tools.
- B. If you aren't sure of a "set up" in a machine, ask before beginning work for safety purposes as well as machine and material damage.
- C. Always replace tools, etc., to 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.

## Engineering Student's Machine Shop Handbook

- F. Be thoughtful and helpful toward others in the shop. Bring any safety violations to the attention of the shop personnel.
- G. Select the proper size and type of tool for your work. Inform the shop technician if tools are broken, have loose handles, or need adjustments. If you can't find what you need, **ASK**.
- 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 (mainly for woodwork).
- K. Do not "rush or tear" through your work. A steady, unhurried pace is safest and will produce the best results.
- L. The floor should be clear of scrap blocks and excessive litter. Immediately wipe up any liquids spilled on the floor.
- M. Report all injuries to your instructor immediately.
  - 1) If student is injured he can be taken to Student Health.
  - 2) Faculty and staff must be taken to the hospital.
  - 3) 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.
- 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 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.
- 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 before making adjustments or measurements.
- 5) Remember that the chips are razor sharp. Do not attempt to remove chips with your fingers. Stop machine and use pliers to remove them.
- 6) Support all work solidly. Do not permit small diameter work to project too far from the chuck without support from the tailstock center.
- 7) 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 or dogs, if possible, until you are familiar with the machine.
- 8) 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.
- 9) 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 carriage a safe distance from your work and "pre-trial" it before the actual use is made.
- 10) NEVER leave the key (T-handle) in the chuck. Make it a habit never to let go of the key until it is out of the chuck and clear of the work area.
- 11) Tools must not be placed on the lathe ways.
- 12) Never use a file without a handle.
- 13) Stop the machine immediately if some odd noise or vibration develops while you are operating it. Tell your instructor 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.
- 15) Clean lathe with brush or "Shop Vac." Do not use air hoses.

### 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

- 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.

### D. 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 only.
- 4) Pick up your scraps from the floor and deposit in trash can.

### E. Drill Press

- 1) Wear eye protection.
- 2) Check the speed setting to see that it is correct for your work. Holes over 1/2 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.
- 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.
- 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.
- 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 technician 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. Table Saw

- 1) Use eye protection.
- 2) USE push sticks! Make it a habit - not something you do when the instructor is around.
- 3) Set the blade so it is 1/4" above the stock to be cut.
- 4) Stand to one side of the operating blade and DO NOT reach across it.
- 5) Maintain a 4 inch margin of safety.
- 6) The position of the stock must be controlled either by the fence or the miter gauge. Do not use both in combination at the same time as this will cause binding and kick back at the end of the cut. NEVER cut stock free hand.

- 7) Use only new stock that is free of knots, splits, and warp.
- 8) Stop the saw before making adjustments to the fence or blade.
- 9) Do not let small scrap cuttings accumulate around the saw blade. Use a push stick to push them away.
- 10) The dado or any special blades should be removed and put away after use. Be sure to replace the original blade.
- 11) As you complete your work, turn off the machine and remain until the blade has stopped. Clear the saw table and place waste cuttings in the scrap box.
- 12) Sweep sawdust and scraps from floor.
- 13) Use splitter and guard whenever possible.

### 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.
- 4) Turn on the switch for a moment to see if the bit is properly centered and running true.
- 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.
- 7) Always remove the bit from the drill as soon as you have finished your work and put it away.

### I. Portable Router

- 1) Use eye protection.

- 2) The bit must be securely mounted in the chuck to a depth of at least 1/2" and the base must be tight.
- 3) Be certain the work is securely clamped and that it will remain stationary during the routing operation.
- 4) Place the router base on the work or template with the bit clear of the stock before turning on the power. Hold it firmly when turning on the motor to overcome starting torque.
- 5) Hold the router in both hands and feed it smoothly through the cut in the correct direction.
- 6) When the cut is complete, turn off the motor and do not lift the machine from the work until the motor has stopped.
- 7) Always unplug the motor when mounting bits or making major adjustments.

### J. Saber Saw

- 1) Use eye protection.
- 2) Select the correct blade for your work and be sure it is properly mounted.
- 3) Disconnect the saw to change blades or make adjustments.
- 4) Make sure the switch is OFF 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.

### K. 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.
- 5) Sand ONLY on the side of the disk sander that is moving down toward the table. Move the work along this surface so it will not burn.
- 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

#### A. Safety precautions for Arc Welding

- 1) Make sure your arc welding equipment is installed properly and 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.
- 10) Do not weld on sealed containers or compartments without providing vents and taking special precautions.
- 11) Use mechanical exhaust at the point of welding 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 ventilations. 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:
  - (a) Open acetylene cylinder valve.
  - (b) Open acetylene torch valve 1/4 turn.
  - (c) Screw in acetylene regulator adjusting valve handle to working pressure.
  - (d) Turn off acetylene torch valve (you will have purged the acetylene line).
  - (e) Slowly open oxygen cylinder valve all the way.
  - (f) Open oxygen torch valve 1/4 turn.
  - (g) Screw in oxygen regulator screw to working pressure.
  - (h) Turn off oxygen torch valve (you will have purged the oxygen line).
  - (i) Open acetylene torch valve 1/4 turn and light with lighter (only use friction type lighter or lighting device provided).
  - (j) Open oxygen torch 1/4 turn.
  - (k) Adjust to neutral flame.
- 15) Always use this correct sequence and technique of shutting off a torch:
  - (a) Close acetylene torch valve first, then close oxygen torch valve.
  - (b) Close cylinder valves - the acetylene valve first, then the oxygen valve.
  - (c) Open torch acetylene and oxygen valves (to release pressure in the regulator and hose).
  - (d) Back off regulator adjusting valve handle until no spring tension is felt.
  - (e) 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. Gloves should be clean and not oily. Welding helmets should be checked occasionally for cracks, and filter glasses 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.
- 3) Make sure the part is clamped securely before drilling.
- 4) Use a center drill to start a hole before drilling.

B. 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.

**TAPPING HOLES**

General Notes:

- 1) Refer to chart for drill sizes.
- 2) Always use cutting oil or tapmatic whenever possible. Tap cast iron dry. When tapping plexiglass, use the Cimcool coolant or the DoAll wax.
- 3) Use a tapping guide block whenever possible.
- 4) 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.
- 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.

## Engineering Student's Machine Shop Handbook

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.
- 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