

MAE Student / Faculty Shop

FACILITY SAFETY, ATTENDANCE LOG and RESPECT

Facility Safety:

To remain in this facility, you **MUST**:

1. **Wear EYE PROTECTION at all times**
2. **Wear PROPER FOOTWEAR**
3. **Wear LONG PANTS**

Before using any equipment in this facility, you **MUST**:

1. **Remove all loose clothing** that might get caught in moving machinery
2. **Remove all jewelry** from hands and wrists
3. **Tie back hair** longer than shoulder length and remove any hats
4. Have in your possession and be familiar with the **Equipment Safety Sheets** for any machine you use (laminated copies will be available for your reference)
5. **Ask a TA before using any machine or tool EACH TIME**

When using any equipment in this facility you **MUST**:

1. **NEVER bring ANYTHING within 6" of the cutting zone while the machine is ON** (fingers, calipers, rulers, rags, etcetera)
2. **NEVER touch cutting chips** with your bare hands
3. **Treat EVERY piece of material as a RAZOR SHARP KNIFE** that can cause a severe laceration if not handled cautiously and deburred after each operation
4. Work in the presence of a facility TA and obey **ALL** instructions he/she gives

Finally, if you use this facility, **PLEASE**:

1. **INSPECT tools before and after use and REPORT broken tools to lab staff**
2. **Leave each machine, station, table, and tool CLEANER than you found it**
3. **Know the TAs are NEVER TOO BUSY TO ANSWER YOUR QUESTIONS**

Final notes about facility use:

1. Be a currently enrolled student, staff or faculty member **in the MAE Department** (please bring your UFID with you)
 2. Have in your possession a **COMPLETE drawing** for the work you wish to perform
 3. **Provide your own tooling for ANY work with non-ferrous metals** (we can guide you with tooling recommendations from local vendors)
 4. **Only work on jobs requiring less than 2 hours per part.** If others are waiting to use the shop, larger jobs should be outsourced to professional shops due to our limited resources and the number of users we try to serve; we can provide a list of local shops
 5. **Be respectful of the TAs managing the shop;** please ask lots of questions, but be sure to **obey their instructions and leave adequate time to cleanup by the end of the hours of operation each time you use the shop**
 6. **Understand that rushed jobs will not be accommodated in this shop,** as such situations are much more likely to result in an accident or equipment damage; if time is of the essence, please seek the assistance of a professional shop
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Attendance Log:

All students using the shop must sign the user roster each session before beginning work.

Cleanliness/Respect:

Student *Cleanliness/Respect* is a subjective assessment of the students' overall attitude in the MAE student/faculty shop. The cleanliness portion of the category refers to the effort each student puts forth to clean up the machines and work area he/she uses. The shop instructor's job is *not* to clean up after the students but rather to instruct them in proper and safe use of the equipment. The respect portion of this category is used to judge the amount of care the students take when using each piece of equipment and when listening to the shop staff. **Arrogant or obstinate behavior has no place in the shop and will not be tolerated.** Students who fail to listen to TA instruction will lose shop privileges, as personal safety is our top priority.

MAE Student / Faculty Shop

General Shop Safety

Introduction:

This handout is designed to acquaint new students with common shop hazards. The goal is to prevent injuries to the people who use this shop. This document will always be posted on the shop website for convenient access. Each student is expected to be familiar with the safety and operation instructions for each piece of equipment he/she uses in the shop. **You must have these safety sheets any time you are working on the laboratory equipment.**

Consult the following safety rules frequently until they are committed to memory.

Ignorance is no excuse for improper or unsafe behavior in this laboratory. Take the time to learn how to safely operate each tool you need to use. Once you know how to use a tool safely, scrupulously follow safe procedures. Beware that familiarity can breed haste. Be careful to think through each operation before you perform it. Do not do anything that seems unsafe. **When you encounter a situation you are unsure of with regard to safety, consult an instructor *before* proceeding.**

The TAs job is to help you safely use the shop. However, we cannot be everywhere at once. Each individual using the shop must take responsibility for the safe use of the facility. If you are unsure of the proper method to do something, wait and ask for guidance. If you notice an unsafe condition in the shop, fix it or bring it to the attention of the TA.

YOUR PERSONAL SAFETY IS OUR NUMBER ONE CONCERN.

General Safety:

The following rules apply to everyone working in the MAE Student / Faculty Shop; they are intended to provide guidelines for working safely as well as familiarize you with some of the common hazards that exist in the shop.

- 1. Familiarize yourself with the layout of the laboratory.** Note the location of the first aid kit, eye wash station and the emergency phone.
- 2. Get checked out by a TA the first time you use each machine or process in the shop. Do not operate any machinery with which you are unfamiliar.** Every tool in the shop has safe operating procedures associated with it. Do not work on any tool in the shop until a TA has introduced you to its safe operation, regardless of whether you have been taught how to operate similar tools elsewhere.

General Safety (con't):

3. **Wear all necessary protective gear and clothing.**
 - **Always wear safety glasses when in the shop.**
 - **Always wear shoes that completely enclose your feet: no sandals, flip-flops, etc.**
 - **Always wear long pants to protect your lower body.**
 - Hearing protection is available from the shop instructors in the form of foam ear inserts. If issued a pair, keep them for future use in the shop.
 - Certain dusts require respiratory protection. Access to respirators will be provided when necessary or requested to protect against airborne hazards.

4. **Remove all personal accessories and loose clothing that might get caught in moving machinery.** This includes rings, watches, jewelry, personal stereos, ties, and open jackets. Anything that hangs loosely from your body can get caught in rotating machinery. *Loose garments must not be worn in the shop.* Tuck in loose fitting shirts and sweat pants ties. Roll up or remove loose sleeves (wear short sleeves whenever possible). Keep tight fitting jackets closed. Do not wear headphones while working in the shop.

5. **Long hair must be securely tied up.** Most of the power tools in the shop make use of a rotating shaft. In use the shaft is frequently sticky with oil. Long, loose hair can get caught on the rotating shaft and pull the owner's head into the cutting zone. Long hair must be kept out of harm's way by tying it up. Rubber bands are always available for this purpose.

6. **Never work alone or without an instructor present.** When working in the shop you must have a second person present who is capable of assisting in the event of an accident. That second person must be able to see you while you are working, and get to you if you need help. If the second person moves to a place where they can no longer maintain visual contact with you, you must cease working. Dial 9-911 for emergency assistance.

7. **Never work when impaired.** This includes times when you are tired, stressed, or otherwise inhibited from exercising appropriate caution in the shop. Do not enter the shop when you are under the influence of any medications that might make you drowsy or alter your ability to be alert. Do not use the shop when you are too frantic to think clearly and carefully. Try to avoid last minute shop work in favor of a consistent weekly effort. Deadline-driven haste can lead to ruined projects and serious injuries.

8. **Never leave a chuck key in a chuck. IF THE CHUCK KEY IS IN USE YOUR HAND MUST BE ON IT.** Chuck keys can be launched across the shop if they are left in place. The start up power of the lathes can throw these tools with enough force to fatally injure someone. It is an easy and terribly dangerous thing to do, so pay attention.

General Safety (con't):

9. Never leave a machine running unattended (for even the shortest amount of time).

Many of the tools in the shop can be set to cut automatically. If you are focused on the process, you will be more likely to react appropriately in the event of a problem.

10. Keep your hands away from the point of contact between the work piece and the cutter.

- **Keep all parts of yourself at least 6 inches from the point of contact between any work piece and any cutter.**
- **Take careful notice of the exact position and size of the workpiece and cutting tool before turning the machine on, as once in motion the true size is deceptive.** This is one of the leading causes of machine shop accidents, so be especially cautious of this around milling cutters and lathe chucks.
- **NEVER remove chips with your fingers. Use compressed air or rags.**

11. Support work pieces and cutting tools as securely as possible. A vibrating setup is an indication that the work piece is not clamped strongly enough to resist the applied cutting forces. You must take the time to secure the setup to resist the force of cutting or use a different operation to do the job. **Do not try to make do with a flimsy set-up, as you, the tool and the workpiece will all be harmed.** If you must hold the work by hand to keep it in place, your set-up is unsafe; improve it. If the tool or work piece is vibrating, the chances are high for a sudden shift in the set-up. **If you are holding the tool or workpiece, you will not be able to get out of the way when something bad happens.**

12. Exercise caution when using the compressed air guns. Never operate without adequate eye protection. Never aim one at another person as it can shoot debris at a high velocity and cause retina damage and permanent sight loss. All the machining stations have been setup with safety blowguns that allow the operator to easily control the amount of air coming out of the gun. Never squeeze the trigger all the way quickly, as that will make a loud noise which can startle another operator, causing an avoidable accident.

13. Act maturely in the shop. One momentary distraction or surprise can result in a severe accident. What might be funny somewhere else could startle someone in the lab and cause them to seriously injure themselves and/or others. So please act mature any time you are working in the shop.

Clean Up Procedures:

Systematic clean up is part of the safe operation of the shop. If someone cannot find a needed tool in its regular place or if he/she is required to work in someone else's mess, the result will be frustration. It is difficult to keep safety in mind when you are frustrated. So it is crucial to keep the shop clean with everything returned to the correct location at the end of its use.

Do not let your guard down when you are cleaning up. Many of the accidents which occur in the machine shop environment occur during clean up. So please continue to be vigilant.

- 1. Shut off power to the machine.** Turn off the main power switch for the machine. If the machine has an emergency stop switch, depress it. Disengage all power feeds.
- 2. Un-mount all cutters and tooling.** Many people cut themselves trying to clean up around mounted cutting tools. Remove all end mills, lathe tools and drill bits from their tool holders and put away in their proper storage locations.
- 3. Put away all measuring tools, hand tools, material scraps, and drawings.** Put away all items that do not belong permanently with the machine. If you do not know the correct location of an item, ask a shop instructor.
- 4. Clean chips and excess oil from machines and chip pans.** Protect your hands from sharp chips with a shop rag. **Most machines should be wiped down with a shop rag and the spray bottle of cleaner located near the machine.** If you must use compressed air, be careful with it (refer to the appropriate rules of blowgun safety) and use it early in the clean up process. You should clean the equipment well enough that the next user will not be able to tell what material you were working with. *The machine should always be left cleaner than when you began working on it.*
- 5. Sweep the floor around the area of the machines you have used.** Be careful not to strike your body on any knobs, handles or corners of the machine as you clean around it.
- 6. Report missing or broken tools to the shop staff.** Almost everything in the shop can be repaired or replaced, but we need to know about problems in order to correct them. Unless the cause was intentional disrespect for a piece of equipment or staff instruction, **you will never be reprimanded for breaking any tooling, so please don't hesitate to inform the laboratory staff so we can replace or repair the necessary tooling in a timely manner.**
- 7. Clean up your personal work area.** Put all the tools away in their proper locations, clean off your work bench and sweep the floor and surrounding area around your work table.

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Emergency Response Procedures

As stated previously, this handout is intended to acquaint new students with common shop hazards. However, **despite our best intentions, the occasional accident is going to happen** since we are working in a modern manufacturing facility. The purpose of this section is to outline common emergency response procedures in the event of an accident.

Accident Response Levels:

1. **TA ASSISTANCE:** for **minor cuts** (not requiring stitches), **abrasions or burns**
2. **INFIRMARY:** for **more serious, yet non-severe injuries** (like cuts requiring stitches)
3. **EMERGENCY ROOM:** for **serious injuries** (like deep lacerations that won't clot)

Infirmary Information:

Hours of Operation: FALL/SPRING: M-F 8-5 pm; Sunday 12-4 pm
SUMMER: M-F 8-4:30 pm; Sunday 12-4 pm

Phone Number: (352) 392-1161

Accident Response Protocols:

1. In the Event of an Injury:
 - a. Try to remain calm.
 - b. Alert the TA so (s)he can help after putting on gloves.
 - c. If the injury does not prevent you from walking, move to the bathroom with assistance. Never walk alone, as it is possible to become dizzy and faint, which can cause an even worse injury.
 - d. If you can't walk, sit in a chair and let the TA assist you.
 - e. If the injury is minor to moderate, allow a TA to stabilize the wound and if necessary escort you to the infirmary.
 - f. If the injury is severe, call for emergency medical assistance (i.e. paramedics and an ambulance by dialing 911) or allow a TA to drive you to the E.R. at Shands.
2. The first aid kit is located on the main door you pass through when entering and leaving the facility. Use any items necessary from the kits, but please let the shop manager know if the first aid kit runs low on consumables. The first aid kits contain the following items for dealing with accidental injuries:
 - a. nitrile gloves
 - b. band aids
 - c. antiseptic
 - d. gauze pads
 - e. medical tape
 - f. burn gel
 - g. tourniquet
 - h. scissors

Accident Response Protocols (cont):

3. Cuts and Abrasions:

- a. Always wear gloves when offering medical assistance to another person.
- b. Control the bleeding by firmly covering the area of the wound with a sterile bandage or gauze to assist in clotting
- c. If possible rinse the wound with soap and water and gently blot the area
- d. Apply antiseptic (ointment or spray) on a sterile bandage or gauze.
- e. Cover small cuts with appropriately sized band-aids or butterfly bandages.
- f. Cover larger cuts with gauze and medical tape. If possible, apply blood clotting spray to the gauze before covering the wound and securing with the medical tape.
- g. Seek professional medical attention if you notice signs of infection, like increased pain, redness, swelling, fever or oozing.

4. Burns:

- a. For minor (1st degree) burns (skin is not burned all the way through the outer layer; appears red and sore; covers a small area):
 - i. Apply cool water to the area of the burn for 10-15 minutes or cool the burn with cold compresses (never put ice on the burn).
 - ii. Gently blot the area to dry it.
 - iii. Gently apply burn gel, but don't cover the wound so it can remain cool.
- b. For moderate (2nd degree) burns approximately 3" in size or smaller (first layer of skin is burned through and second layer is also burned; appears blistered and painful):
 - i. Apply cool water to the area of the burn for 10-15 minutes or cool the burn with cold compresses (never put ice on the burn).
 - ii. Cover the burn with a sterile gauze bandage. Don't use fluffy cotton, or other material that may get lint in the wound. Wrap the gauze loosely to avoid putting pressure on burned skin. Bandaging keeps air off the burn, reduces pain and protects blistered skin.
 - iii. Take an over-the-counter pain reliever like aspirin, ibuprofen (Advil, Motrin, others), naproxen (Aleve) or acetaminophen (Tylenol, others).
- c. For major (3rd degree) burns larger than 3" or on hands, feet, face, groin, buttocks or major joints (burns involving all layers of skin; usually no pain and causes skin to be white or charred):
 - i. Call 911 for emergency medical help.
 - ii. Don't remove burned clothing or immerse large severe burns in cold water.
 - iii. Elevate the burned body part(s).
 - iv. Cover the area of the burn using a moist sterile bandage or moist cloth towels.

Accident Response Protocols (cont):

- d. For minor or moderate burns, seek professional medical attention if you notice signs of infection, like increased pain, redness, swelling, fever or oozing.
5. Foreign Debris in Eye(s):
- a. Eyewash bottles are located in the bathroom and on the wall by the lab rotisserie.
 - b. If you need to use a bottle, flush your eyes with the entire contents of the bottle for at least 15 minutes to ensure the foreign substance is removed from your eye.
 - c. When rinsing, forcibly hold eye open to ensure effective rinsing behind eyelids. Move eye side-to-side and up-down during rinsing to allow the water to carry the foreign debris out of the eye. Remove contact lenses as well.
 - d. When done, blot the area around your eye lightly with a paper towel, but never rub your eye to dry it (in case there's still anything still inside).

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BANDSAW SAFETY

(DoALL) Vertical Bandsaw:

1. **Always wear safety glasses** when operating the bandsaw.
2. **Never wear gloves** as they could get caught on the moving teeth and pull your hands into the moving blade, causing a severe injury.
3. **The upper guide and guard should be set to within ¼ inch of the workpiece.** Adjust the guard with the machine turned off.
4. Use a push block for small work so if your hand slips off it will not swing into the blade.
5. Do not push the workpiece into the blade hard enough to cause the machine to chatter; slow down and find a more rigid manner in which to support/clamp the work in the saw.
6. **Never cut materials that might be hardened, such as tool steel, files, stainless steel, etc.** Any material that cannot be cut easily with a standard hand file or hacksaw should never be cut in a bandsaw; an abrasive cutoff saw must be used instead.
7. If the band breaks, immediately shut off the power and stand clear until the machine has stopped. Promptly inform the laboratory staff so a replacement blade can be installed.

(Roll-In) Vertical Gravity Feed Bandsaw:

1. **Make sure the workpiece is clamped securely before turning on the saw. Failure to do so will result in the workpiece dislodging from the vise and breaking the saw blade.**
2. **Do not push the blade into the workpiece hard enough to cause the machine to chatter;** slow down and/or find a more rigid manner in which to clamp the work in the saw.
3. **Always bring the blade into contact with the material before engaging the gravity feed.** The proper procedure is as follows: (1) firmly clamp the workpiece in the vise; (2) turn on the saw so the blade is rotating; (3) gently bring the moveable saw blade into *light* contact with the workpiece by rotating the hydraulic feed knob; (4) keep your hand on the feed knob while the cut is being made; (5) retract the blade carriage after the workpiece is cut but before the blade passes the remaining stock in the vise; (6) return the carriage to its original (starting) position; (7) turn off the saw.
4. **Never leave the machine unattended while cutting.**

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CALIPER USE AND SAFETY

1. Always treat the calipers gently, as **they are very fragile**. If misused, they will not measure correctly and your part will not be the proper size. *Translation: abuse of the calipers means you will be wasting your money buying another pair and your time making another part.*
2. **Always leave the calipers in the plastic storage boxes when they are not in your hand being used.** Close the lid to the box so chips do not get inside and damage the calipers. Stated another way, **NEVER leave the calipers sitting on the machines;** the small cutting chips will end up inside the delicate gears on the calipers and destroy them.
3. The calipers are only to be used as a precision measuring device. **They are not to be used as clamps, scribes, wrenches, punches, weapons of mass destruction, etcetera.**
4. **Be careful not to drop the calipers,** as doing so will ruin their calibration and precision.
5. **Open and close the calipers slowly** with one hand to reduce the wear on the rack & pinion gears inside the caliper body. Rapidly adjusting the calipers will quickly destroy them.
6. **Always wipe chips and oil off the part(s) to be measured** before bringing the calipers into contact with the part(s).
7. **Always wipe the caliper jaws off** before use.
8. **Always ensure the calipers are zeroed** before making a measurement.
9. **Always measure the part twice** to ensure repeatability of the measurement.
10. **NEVER measure a part on the machine while the spindle is running.** Always turn the machine off first and wait for the workpiece or tool to come to a complete stop before performing a measurement.

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CHEMICAL AND SOLVENT SAFETY

- 11. Avoid skin contact.** Wear latex gloves which are available in the safety storage cabinet.
- 12. Never use volatile solvents** around hot metal surfaces, sparks or flames. Likewise, never light flames in areas where solvents are used or stored.
- 13. Do not use chemicals or solvents in confined, unventilated areas.**
- 14. Always use solvents over a spill pan to catch any solvent that accidentally spills.**
- 15. Clean up any spills immediately using rags (for small quantities) or absorbent pads (for larger quantities). Properly dispose of the solvent soaked rags or absorbent pads in the proper (labeled) canister.**
- 16. Develop and maintain good personal hygiene habits. Remove protective equipment and wash thoroughly with warm soapy water immediately after contact with solvents.**
- 17. Always put chemicals and solvents back in the proper location immediately after use.**
- 18. Never bring unauthorized chemicals into the laboratory.**

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DISC AND BELT SANDER SAFETY

1. **Always wear safety glasses** when operating the sanders.
2. **Never wear gloves** as they could get caught between the belt and the table and pull your hands into the machine, resulting in severe abrasion.
3. On the disc sander always use the downward motion side of the disc to sand. **Never use the upward motion side of the disc, as this can throw the workpiece upwards with TREMENDOUS force.**
4. **Always place your work against the steady rest on the sanders.** Never try to freely support the workpiece and bring it into contact with the rotating disc.
5. On the horizontal belt sander, **always sand so the belt motion is away from you** in case you lose control of the workpiece.
6. **Never operate machines with torn belts or disks.**
7. **Do not sand any material that will produce hazardous dust.** Such materials as galvanized coated metals, copper beryllium alloys, etc. must not be sanded or filed without proper respirators. Asbestos must not be sanded (asbestos is an ingredient of brake shoes and pads). When sanding aluminum for more than 20 seconds (or sanding pieces repeatedly), wear a respirator which is available in the safety storage cabinet.
8. **Never sand parts that are extremely hot**, as doing so will overheat and destroy the sanding belt or disc. Frequently cool the work using the nearby water container.
9. **When using the BELT sander, gently move the workpiece back and forth sideways over the full width of the belt to distribute belt wear evenly.**
10. **Do not use sanders for bulk (more than 1/8") material removal.** Rather, (re)cut the workpiece in the bandsaw or on the milling machine and *then* sand if necessary.

DRILL PRESS AND HAND DRILL SAFETY

General:

1. **Always wear safety glasses** when operating the drill press.
2. **Always remove the drill chuck key from the spindle immediately after tightening/loosening. Never leave the chuck key engaged in the key chuck.**
3. **Hand drills should be chucked and unchucked with the power cord unplugged** to prevent accidentally turning on the drill motor, which could break your wrist.
4. There are three types of drill bit identifications: (1) numbered, (2) lettered and (3) fractional; do not mix them up. **Note where you take each drill bit from and return it to the proper index (container).**
5. **Never place a drill bit in the wrong location in the drill dispenser or index box.** Doing so can result in someone else grabbing the wrong size drill bit and ruining a part (s)he has invested considerable time in. If unsure of the drill bit size, measure it with a pair of calipers or ask a TA for assistance.

Clamping the Workpiece:

6. Always clamp the workpiece in a vise or directly to the drill table. **NEVER rely on your hands to hold the part to be drilled, as the drill bit can snatch a handheld workpiece and cause severe injury.** Attach smaller sheetmetal workpieces to a larger board which can be properly clamped in the vise or to the drill press table directly.
7. **Always support the workpiece on parallels or a backing board when drilling thru material to prevent drilling into the machine table or vice.** If using parallels, be certain not to drill into them, as this will destroy the drill bit and the parallels.

Drilling:

8. **NEVER attempt to slow the spindle down with your hand after turning off the power.** Let the spindle stop on its own to avoid lacerations from sharp burrs on the drill chuck.
9. **Run drills at an appropriate speed for the diameter of drill bit and material used.** Larger drill bits require slower speeds. Consult an instructor for the correct speed if unsure. A high pitch squealing noise indicates the speed needs to be lowered immediately.

Drilling (con't):

- 10. Always use cutting fluid when drilling holes,** as it greatly extends the usable life of the drill bits by providing lubrication and reducing the temperature in the cutting zone. A few drops of cutting fluid is sufficient for shallow holes.
- 11. Don't use excessive force when drilling;** let the drill bit do the work. If unsure about what “excessive” is for a particular material/drill bit combination, ask an instructor. If excessive force is required the drill bit may be damaged or incorrect for the intended use.
- 12. Reduce the drilling pressure as the drill bit breaks through the bottom of the material.**
- 13. NEVER remove chips with your hands, as they can easily cause severe lacerations (even when the drill press is turned off) and can pull your hand into the rotating drill bit.** Remove chips with a chip-brush or a rag after the spindle has ceased rotating.
- 14. When releasing the drill bit from the chuck, make sure the power is off and hold the drill bit with a rag while loosening the chuck to ensure it does not drop on the table. This is the only time a rag should be used around the machine (besides cleaning).** The rag will protect your hands against the elevated temperature resulting from the drilling action.
- 15. If the drill binds in a hole, stop the machine and turn the spindle backwards by hand to release the bit. Consult a shop instructor before proceeding.**
- 16. When drilling holes, withdraw the drill bit frequently to properly evacuate chips.** This is called peck drilling and produces a more accurate hole and prolongs tool life.

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GRINDER SAFETY

- 1. Always wear safety glasses** or goggles when operating bench or angle grinders. Wire wheel brushes are especially hazardous as they can throw steel wire strands at very high velocities.
- 2. Never operate abrasive wheel machinery** (i.e. bench grinders, angle hand grinders, abrasive chop saws, pneumatic cutoff saws, die grinders, etcetera) **without appropriate guards in place.**
- 3. Toolrests on pedestal grinders must be set within 1/16" of the wheel at all times.**
- 4. Never use a wheel that has been dropped or received a heavy blow,** even though there may be no apparent damage. Such wheels may be weakened enough to fly apart on startup as are not worth the risk.
- 5. Report any cracked, broken or vibrating wheels to the shop instructor.**
- 6. Stand to one side of the wheel(s) when starting grinders in case of wheel damage.**
- 7. Always grind on the outermost face of the grinding wheel; NEVER grind on the side of the grinding wheel.**
- 8. Always hold work securely while grinding and use the toolrest to support the work.**
- 9. NEVER grind aluminum or other soft, nonferrous metals on a standard grinding wheel,** as doing so can close the pores of the wheel, causing it to overheat and explode. **Only grind ferrous metals.** Sanders can be used for nonferrous materials.
- 10. NEVER touch any part of the grinding wheel. If the grinder is running, your hand can get pulled between the grinding wheel and the steady rest.**
- 11. To protect your hands use pliers or vise-grips to hold small pieces.**
- 12. Be especially cautious of your fingers and knuckles around grinders and wire brushes.**
- 13. NEVER use excessive pressure while grinding,** as one slip can result in your hand contacting the wheel and being rapidly abraded.

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LATHE SAFETY

1. **Always wear safety glasses** when operating the lathe.
2. **Remove chuck key from chuck immediately after tightening/loosening the chuck.**
3. **Always verify the toolbit is sharp, is not chipped and has the proper clearance.** Ask for assistance making adjustments.
4. **Set the toolbit on the vertical center line of the workpiece.** Use the 6" ruler to check and set tool height by gently clamping the ruler between the workpiece and the cutting tool.
5. **Always make sure the tool-post is tightened properly before using the lathe.** When tightening, do not apply more than 20 pounds to the end of the tool-post wrench.
6. **Always make sure the spindle is rotating in the proper direction** (CCW looking from the tailstock towards the spindle) **before cutting material.** Failure to do so can result in damaged tooling (and under certain circumstances the chuck can unscrew and fall off).
7. **Don't run the machine faster than the proper cutting speed.** Slower is better if unsure.
8. **Always use cutting fluid for the material being cut.** A little goes a long way.
9. **NEVER remove chips with your hands, as they can easily cause severe lacerations (even when the lathe is turned off) and can pull your hand into the rotating work and the tool.**
10. **NEVER touch any part of the workpiece or machine spindle while the lathe is rotating.** *Make sure that the machine is fully stopped before taking any measurements, checking surface finish, etc.*
11. **Be careful not to run the tool into the chuck.** When in motion the location of the chuck jaws is dangerously deceptive, so note their location and **spin the chuck through one revolution by hand** before turning on the power to ensure there are no clearance problems.
12. Do not remove excessive amounts of material in a single pass. Specifically, **do not remove more than 0.050" off the RADIUS of the workpiece in a single pass.** If the cutting tool begins to chatter, reduce the radial in-feed, spindle speed and/or the feedrate.
13. **Always ask if the lathe's spindle speed and feedrate are to be changed while the machine is running or once it has stopped.** Each machine is different and failure to adjust the machine in the proper manner will result in mechanical damage. **Do not depend on your memory; ALWAYS ask an instructor.**
14. **Always allow the spindle to completely stop turning before reversing the direction of rotation by switching between *forward* and *reverse* on the spindle power switch.**
15. **If any filing is done on work revolving in the lathe, file left handed to prevent slipping into the chuck.** Never use a file without a large handle and always reduce the spindle speed to its lowest setting.
16. **Never try to manually sand a rotating workpiece, as that can easily cause a dislocated finger (or worse).**
17. **Be careful not to slide the tailstock off the machine guideways, thereby allowing it to fall on the floor or on someone's foot.**
18. **Before cleaning the lathe remove tools from the tool post and tailstock.**

MILLING MACHINE SAFETY

General:

1. **Always wear safety glasses** when operating the milling machine.
2. **Work must be either clamped securely** in a vise which is bolted tightly **to the table**, or the work itself must be clamped directly to the table.
3. **Before turning on the machine spindle, make sure the cutter is clear of the workpiece.**
4. **Always allow the spindle to completely stop turning before reversing the direction of rotation by switching between *forward* and *reverse* on the spindle power switch.**
5. **When using the power feed for the table, always allow the table to completely stop moving before reversing direction using the power feed directional joystick. Wait a few seconds for the gearmotor/drive to spin down before changing directions.**
6. **Always make sure cutter is rotating in the proper direction before cutting material (CW as viewed from the top of the spindle looking down towards the workpiece).**
7. **NEVER touch any part of the workpiece or machine spindle while the tool is rotating. *Ensure that the machine is fully stopped before taking any measurements, checking surface finish, etc.***
8. **Always use cutters which are sharp and in good condition.**
9. **Don't place anything on the milling machine table** such as wrenches, hammers, or tools.
10. **Always remain at the machine while it is running.**
11. Do not take too heavy a cut or use too rapid a feed. **Specifically, do not remove more than 0.050" off the workpiece in a single pass.** If the cutting tool begins to chatter, reduce the depth of cut and/or feedrate.
12. **Do not run cutters, drills or other tools into the vice or table.** Be sure to think ahead and check the necessary clearances before machining. If an interference appears possible, stop and re-fixturing the workpiece and/or tooling.
13. **Always ramp gently into contact with the workpiece; never bring the cutter into contact with the workpiece abruptly.**
14. **Always use cutting fluid** when milling, drilling, etc. as it greatly extends the usable life of the tooling by providing lubrication and reducing the temperature in the cutting zone. A little cutting fluid goes a long way.
15. **Never remove chips with your hands, as they can cause severe lacerations (even when the mill is turned off) and can pull your hand into the rotating tool.** Remove chips with a chip-brush or a rag to after the spindle has ceased rotating
16. **Always adjust the spindle speed while the machine is running. NEVER ADJUST THE SPEED WITH THE SPINDLE TURNED OFF.**
17. **Before cleaning the mill remove the cutting tool from the spindle** to avoid cutting yourself on the sharp flutes.

Installing Tools:

18. The proper technique for installing a tool into the mill is as follows:
- a. Make sure the power is off and the spindle has come to a complete stop.
 - b. Move the table so the vice is out of the way of mounting the tool. For longer tools it may also be necessary to lower the table. **Always position one of the plastic side covers below the spindle before changing tools.**
 - c. Release the spindle clamp which is located on the right side of the spindle housing. This lever is about 1-1/2" long and is released by rotating it *counter-clockwise*.
 - d. Raise the spindle to the uppermost position using the quill handle on the right side.
 - e. Raise the spring loaded spindle lock to the uppermost position by depressing the round button, raising it all the way to the top of its travel and releasing the button.
 - f. Select the appropriate collet to fit the shank of the tool to be installed. There should only be enough clearance for a piece of paper to fit between the shank and the collet.
 - g. Inspect the collet to make sure there are no chips on the taper or in the threads.
 - h. Insert the collet into the spindle bore. The collets are keyed and can only be installed in one angular orientation, so it is necessary to slowly spin the collet while lifting it up into the spindle. Once the proper orientation is found the collet will raise approximately 3" into the spindle bore.
 - i. Use your right hand to hold the tool being installed with a rag to protect your fingers against the sharp cutting edges of the tool.
 - j. Now insert the tool into the collet and hold both in the correct position with your right hand. Make sure the collet is clamping on the full diameter of the tool shank.
 - k. When the tool is located at the correct height in the collet, press the GREEN safety button and the RED 'IN' button to the left side of the machine spindle. Hold these buttons engaged for 1-2 seconds until you hear a distinct change in tone signaling the tool and collet are clamped tightly. Release immediately upon hearing this sound.
 - l. Finally, make sure the tool is securely clamped in the collet (using a rag to protect your hand). If it is not, consult a laboratory instructor for assistance.

Removing Tools:

19. The proper technique for removing a tool from the mill is as follows:
- a. Make sure the power is off and the spindle has come to a complete stop.
 - b. Move the table so the vice is out of the way of removing the tool. For longer tools it may also be necessary to lower the table. **Always position one of the plastic side covers below the spindle before changing tools.**
 - c. Release the spindle clamp which is located on the right side of the spindle housing. This lever is about 1-1/2" long and is released by rotating it *counter-clockwise*.
 - d. Raise the spindle to the uppermost position using the quill handle on the right side.
 - e. Raise the spring loaded spindle lock to the uppermost position by depressing the round button, raising it all the way to the top of its travel and releasing the button.
 - f. Hold the tool being removed with a rag to ensure it does not drop on the table. **This is the second time a rag should be used around the spindle (besides cleaning).** The rag will protect your hands against the sharp flutes of the cutter as well as the elevated temperature resulting from the milling process.
 - g. Press the GREEN safety button and the RED 'OUT' button to the left side of the machine spindle. Hold these buttons engaged for 1-2 seconds until the tool and collet are gently released from the machine spindle.
 - h. Carefully wipe the tool and collet off with a rag and return them to their proper storage locations. Do not mix collets between machines.